UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802- 4213

SEP - 5 2003

MEMORANDUM FOR: The Record

FROM: Rodney R. McInnis Rodney R McInnis
Acting Regional Administrator

SUBJECT: Endangered Species Act (ESA) section 7 programmatic biological opinion on the issuance of section 10(a)(1)(A) scientific research permits for take of endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, and threatened Central Valley steelhead.

The attached ESA section 7 programmatic consultation analyzes the issuance of ESA section 10(a)(1)(A) permits for take of endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), and threatened Central Valley steelhead (*O. mykiss*). The issuance of ESA section 10(a)(1)(A) scientific research permits qualifies for a categorical exclusion under the National Environmental Policy Act, therefore, an Environmental Assessment is not required for this action and has not been prepared.

NOAA Fisheries concludes that issuing scientific research permits for the activities discussed in this consultation is not likely to jeopardize the continued existence of endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, and threatened Central Valley steelhead.

Attachment

BIOLOGICAL OPINION

AGENCY: U.S. Department of Commerce, National Marine Fisheries Service (NOAA Fisheries), Southwest Region

ACTIVITY: Issuance of Section 10(a)(1)(A) permits in the California Central Valley

CONSULTATION CONDUCTED BY: NOAA Fisheries, Southwest Region

DATE ISSUED:

I. CONSULTATION HISTORY

Section 10(a)(1)(A) of the Endangered Species Act (ESA) provides NOAA Fisheries with authority to grant exceptions to the ESA's "taking" prohibitions for scientific research (see regulations at 50 CFR 222.301 through 222.308 and 50 CFR 224.101 through 224.102). Section 10(a)(1)(A) scientific research or enhancement permits may be issued to Federal or non-Federal entities conducting research or enhancement activities that involve an intentional "take"[1] of ESA-listed species. Any permitted research or enhancement activities must (1) be applied for in good faith, (2) if granted and exercised, not operate to the disadvantage of the endangered species, and (3) be consistent with the purposes and policy set forth in section 2 of the ESA (50 CFR 222.303(f)). NOAA Fisheries has prepared this biological opinion in compliance with section 7(a)(2) of the ESA, as amended (16 U.S.C. 1536).

Annually, NOAA Fisheries' Southwest Region (SWR) receives scores of applications for new section 10(a)(1)(A) permits or modifications to existing permits. The requirement for consultation for these permits has resulted in a substantial workload for NOAA Fisheries SWR. Currently, the backlog of pending permit actions results in poor constituent (applicant) service and does not assist in the recovery of protected species. To address these issues and in recognition that most research and monitoring activities pose limited risk to the species while offering valuable information, NOAA Fisheries SWR has developed this programmatic biological opinion. Recently published 4(d) rules (65 FR 42422, 67 FR 1116) highlight the value of research in the recovery process, acknowledge the paucity of research data, and encourage scientific research. A programmatic biological opinion will streamline permit issuance and expedite retrieval of information from permittees. Information collected from permit holders will contribute to the monitoring of population trends and assessing the effectiveness of protective actions. A programmatic opinion will allow NOAA Fisheries SWR to more efficiently meet its regulatory requirements and remain compliant with Federal law.

The objective of this programmatic biological opinion is to determine whether the issuance of scientific research permits is likely to jeopardize the continued existence of listed salmonids, or

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[1] **Take** - to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. [ESA §3(19)]

result in the destruction, or adverse modification of designated critical habitat. Specifically, this biological opinion evaluates the impacts of authorizing take under section 10(a)(1)(A) of the ESA for purposes of supporting the recovery of Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), and Central Valley steelhead (*O. mykiss*) through the gathering of scientific information. In preparation of this biological opinion, NOAA Fisheries SWR Protected Resources Division (PRD) identified potential actions that may be proposed under ESA section 10(a)(1)(A) programs relative to scientific research. In developing this biological opinion, NOAA Fisheries SWR PRD considered information from pertinent biological literature, written comments submitted by agencies and the public on the proposed scientific research, and information derived from other sources.

II. DESCRIPTION OF THE PROPOSED ACTION

NOAA Fisheries SWR PRD proposes to issue ESA section 10(a)(1)(A) permits for the purpose of scientific research. Permits would be issued in accordance with the permit procedures and permit issuance criteria of 50 CFR §222.308(c). Under the tiered consultation framework, individual entities will submit an application for a new ESA section 10(a)(1)(A) permit or to modify an existing ESA section 10(a)(1)(A) permit. NOAA Fisheries SWR will review all research proposals to insure that they are consistent with the purposes of the ESA.

Specific activities authorized by these permits are described in Section V of this programmatic biological opinion and may include: surveys by direct observation or capture by electrofisher, nets, trawls, and traps; handling, marking, tagging, attaching radio and sonic transmitters; tissue sampling; and other activities necessary to conduct various studies aimed at the recovery of the species. Activities that are specific to a research project, but not described in this programmatic biological opinion, will be described in the tiering document. Measures to reduce the impacts of research and conditions that NOAA Fisheries will impose to minimize potential effects of research on listed species are described in Section V of this document, in the individual tiering documents, and in the research permit. Only qualified individuals will be authorized to implement these actions. To facilitate the recovery planning process, all data collected as a result of the permitted actions will be reported to NOAA Fisheries SWR PRD for distribution to the NOAA Fisheries' Southwest Fisheries Science Center and Area Recovery Coordinators.

A. Evaluating Future Research Projects

Issuance of permits would be restricted to only those entities performing activities that enhance the propagation or survival of ESA-listed salmonids. In addition, NOAA Fisheries must determine whether the action is likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The standards for determining jeopardy are set forth in section 7(a)(2) of the ESA and in 50 CFR 402 (the consultation regulations). This analysis involves the initial steps of: (1) defining the biological requirements of the listed species; and (2) evaluating the species' current status as listed and within the action area. Subsequently, NOAA Fisheries evaluates whether the action is likely to jeopardize the listed species by determining if the direct and indirect effects of the proposed action and any interrelated and interdependent actions and the cumulative effects, when added to the environmental baseline and the species' current status, would be expected, directly or indirectly, to reduce appreciably the likelihood of survival and recovery of the species in the wild. If NOAA Fisheries finds that the action is likely to jeopardize listed salmonids or adversely modify their habitat, NOAA Fisheries must identify reasonable and prudent alternatives for the action.

Before issuing section 10(a)(1)(A) permits under this opinion, NOAA Fisheries will prepare a memorandum analyzing the expected effects of implementing the proposed action. The analysis will evaluate the proposed activity and ensure that the proposed action satisfies the NOAA Fisheries permit issuance criteria of 50 CFR §222.308(c). The memorandum will tier to this biological opinion, when appropriate, to eliminate repetitive discussions of some issues and to focus on issues specific to the proposed action not already analyzed in this opinion. In addition to the tiered analysis, NOAA Fisheries will prepare a document which includes: a list of public comments received on the proposed project and responses to those comments; a discussion of compliance for all requirements of the National Environmental Policy Act and the Magnuson-Stevens Fisheries Conservation and Management Act; and a discussion of coordination among NOAA Fisheries SWR, NOAA Fisheries Southwest Fisheries Science Center, United States Fish and Wildlife Service, and the National Ocean Service.

The following research activities, given their high inherent risk of injury or mortality to salmonids, would require additional impact analysis in the tiering document: multi-pass backpack electrofishing, boat-based electrofishing, intentional adult capture, use of gill nets, enhancement activities, and experimental relocations. Permit applications for these and other high-risk activities would be subject to additional detailed assessment of effects in the tiered analysis. Intentional lethal take of listed salmonids, a rare research request, is not covered by this opinion and will be subject to separate consultation.

As part of this programmatic consultation, approximately one year from issuance of this biological opinion, NOAA Fisheries will reassess the research projects authorized herein to ensure that they benefit the conservation of winter-run Chinook salmon, spring-run Chinook salmon, and steelhead. NOAA Fisheries SWR field offices will be responsible for making specific determinations to ensure that take authorized under this program does not reduce the potential for listed anadromous fish populations to survive and recover on an Evolutionarily Significant Unit (ESU)[2]-scale or adversely modify designated critical habitat.

B. Description of the Action Area

[2] For purposes of conservation under the Endangered Species Act, an Evolutionarily Significant Unit (ESU) is a distinct population segment that is substantially reproductively isolated from other conspecific population units and represents an important component in the evolutionary legacy of the species (Waples 1991).

The action area includes streams draining into the Sacramento and San Joaquin River Basins in the Central Valley of California (Figure 1), and encompasses the geographic areas included within the winter-run and spring-run Chinook salmon and Central Valley steelhead ESUs (Figure 2).

III. DESCRIPTION AND STATUS OF THE SPECIES AND CRITICAL HABITAT

This biological opinion analyzes the effects of the proposed permit issuance program on the following listed species:

Sacramento River winter-run Chinook salmon — endangered
Central Valley spring-run Chinook salmon — threatened
Central Valley steelhead — threatened

More detailed information related to the listing status, critical habitat, protective regulations, and biological information for the ESA-listed species addressed in this opinion are found in Table 1.

The research activities NOAA Fisheries expects to cover with this programmatic opinion do not result in any changes or effects to salmonid habitat. Therefore, critical habitat is not likely to be affected by the proposed permit issuance program and is not considered further in this opinion.

A. Species Descriptions of Chinook Salmon

1. Sacramento River winter-run Chinook salmon

Since 1967, the California Department of Fish and Game (DFG) has conducted annual population estimates of winter-run Chinook salmon. When a 75 percent decline from the consistently low run size was observed in 1989, NOAA Fisheries issued an emergency interim rule listing the winter-run Chinook salmon as threatened under the ESA in August 1989 (54 FR 32085). NOAA Fisheries subsequently published a proposed rule to list winter-run Chinook salmon as threatened in March 1990 (55 FR 10260). NOAA Fisheries issued a second emergency interim rule listing winter-run Chinook salmon as threatened in April 1990 (55 FR 12191) to avoid a hiatus in protection of the species until the formal listing process was completed. NOAA Fisheries published a final rule listing the species as threatened under the ESA in November 1990 (55 FR 46515). After conducting another status review, NOAA Fisheries published a final ruling in January 1994 reclassifying winter-run Chinook salmon as endangered under the ESA (59 FR 440).

2. Central Valley spring-run Chinook salmon

The Central Valley spring-run Chinook salmon was originally proposed as endangered, but after soliciting additional data to resolve scientific disagreements, NOAA Fisheries issued a final ruling to list the Central Valley spring-run Chinook salmon as threatened in September 1999 (64

FR 50394). This listing includes only naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries.

B. Status of Stocks of Chinook Salmon

1. Sacramento River winter-run Chinook salmon

The distribution of winter-run Chinook salmon was historically limited to the Upper Sacramento River, where spring-fed streams allow for spawning, incubation, and rearing in cold water flows (Slater 1963, Yoshiyama et al. 1998). Access to historical spawning habitat for winter-run Chinook salmon has been eliminated by dams and other in-river barriers. For example, since Shasta Dam was constructed in 1945, winter-run Chinook salmon can no longer spawn in the McCloud, Pit, and Little Sacramento Rivers, and have subsequently been reduced to a single population restricted to spawning within approximately 44 miles of the mainstem Sacramento River below Keswick Dam (Reynolds et al. 1993, NOAA Fisheries 1997a).

Long-term trends in abundance of winter-run Chinook salmon are determined based on annual counts of spawners passing over the Red Bluff Diversion Dam ladders to access existing spawning grounds. Run size declined from a high of 117,808 in 1969 to a low of 189 winter-run Chinook salmon in 1994 (DFG 2002). The downward trend continued in the 1990’s and is slowly increasing (Figure 3).

2. Central Valley spring-run Chinook salmon

The Central Valley spring-run Chinook salmon ESU has had the most dramatic decline of the four Chinook salmon runs in the Central Valley (Campbell and Moyle 1990; Fisher 1994). The main threats to spring-run Chinook salmon include loss of most historic spawning habitat, degradation of remaining habitat, and genetic threats from the Feather River Hatchery spring-run Chinook salmon program (NOAA Fisheries 2003). The majority of the large populations of spring-run Chinook salmon in the Central Valley has been extirpated and the remaining populations have been significantly reduced (Campbell and Moyle 1990). Spring-run Chinook salmon have displayed broad fluctuations in abundance, ranging from lows of 426 in 1966 and 3,044 in 1998 to highs of 27,890 in 1982 and 33,771 in 1998 (Figure 4).

Historically, spring-run Chinook salmon were predominant throughout the Central Valley, occupying the upper and middle reaches of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud, and Pit Rivers, with smaller populations in other tributaries with sufficient habitat for over-summering adults (Stone 1874, Rutter 1904, Clark 1929). In the late 1940's, spring-run Chinook salmon were extirpated from the upper San Joaquin River, and only remnant populations persisted in the San Joaquin basin through the 1950's.

Spring-run Chinook salmon now are restricted to the Sacramento River drainage. Hybridization with fall-run Chinook salmon in several Sacramento Valley streams threaten their ability to remain a distinct race in the mainstem Sacramento River (Slater 1963). For example, based on coded wire tag identifications, nearly a quarter of returning spawners to the Feather River Hatchery were spring-fall hybrids (DFG, unpublished data). Self-sustaining wild populations of spring-run Chinook salmon occur only in Mill, Deer, and Butte Creeks in the Sacramento River drainage, and remain vulnerable to extirpation (NOAA Fisheries 2003).

C. Life History and Biological Requirements of Chinook Salmon

Chinook salmon are anadromous and the largest member of *Oncorhynchus*, with adults weighing more than 120 pounds having been reported from North American waters (Scott and Crossman 1973, Eschmeyer et al. 1983, Page and Burr 1991). Chinook salmon exhibit two main life history strategies: ocean-type fish and river-type fish (Healey 1991). Ocean-type fish typically are fall- or winter-run fish that enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of rivers, spawn within a few weeks of freshwater entry and have offspring that emigrate shortly after emergence from the redd (Healey 1991). River-type fish typically are spring- or summer-run fish that have a protracted adult freshwater residency, sometimes spawning several months after entering freshwater. Progeny of river-type fish frequently spend one or more years in freshwater before emigrating. In the Sacramento River, 10-18 percent of Chinook salmon spawning runs are stream-type fish (e.g., spring-run Chinook salmon) and 82-90 percent are ocean-type (e.g., fall-run Chinook salmon; Healey 1991).

Chinook salmon in the Central Valley generally remain in the ocean for two to five years (Healey 1991), and tend to stay along the California coast (NOAA Fisheries 1997a). Some Chinook salmon return from the ocean to spawn one or more years before becoming full-sized adults, and are referred to as jacks (males) and jills (females). Because the Sacramento River supports four seasonal runs of Chinook salmon, Chinook salmon spawning populations are present in the river throughout the year. Winter-run Chinook salmon typically migrate to the Sacramento River from December to June, and spawn between May and June in the Upper Sacramento River. Spring-run Chinook salmon typically migrate to the Sacramento River from March to July, and spawn late August to October in the upper reaches of the Sacramento River and principle tributaries. Fall and late fall-run Chinook salmon typically migrate upstream from July to December, and January to April, respectively, and spawn shortly thereafter in the middle and lower reaches of the Sacramento and San Joaquin Rivers.

Egg deposition must be timed to insure that fry emerge during the following spring at a time when the river or estuary productivity is sufficient for juvenile survival and growth. Adult female Chinook salmon prepare redds in stream areas with suitable gravel composition, water depth, and velocity. Spawning generally occurs in swift, relatively shallow riffles or along the edges of fast runs at depths greater than 24 cm. Optimal spawning temperatures range between 5.6-13.9 °C. Redds vary widely in size and location within the river. Preferred spawning substrate is clean, loose gravel, mostly sized between 1.3-10.2 cm (Allen and Hassler 1986). Embryo survival is strongly correlated with the proportion of substrates in the range of 0.85 mm to 9.50 mm. Survival decreases significantly as the percent of 0.85 mm material increases beyond 10 percent and as 9.50 mm material increases beyond 25 percent (Tappel and Bjornn

1983). Reiser and White (1988) indicated dramatic decreases in survival with fines (<0.84 mm) greater than 10 percent. Geometric mean particle size diameters of 8 mm to 15 mm also result in a marked reduction in survival of Chinook salmon embryos (Shirazi and Seim 1979, Tappel and Bjornn 1983). Gravels are unsuitable when they have been cemented with clay or fines or when sediments settle out onto redds, reducing intergravel percolation. Minimum intragravel percolation rate depends on flow rate, water depth, and water quality. The percolation rate must be adequate to maintain oxygen delivery to the eggs and remove metabolic wastes. The Chinook salmon's need for a strong, constant level of subsurface flow may indicate that suitable spawning habitat is more limited in most rivers than superficial observation would suggest. After depositing eggs in a redd, adult Chinook salmon guard the redd from 4 to 25 days before dying.

Chinook salmon eggs incubate for 90 to 150 days, depending on water temperature. Eggs of winter-run Chinook salmon and spring-run Chinook salmon usually hatch in 40-60 days. Winter-run Chinook salmon fry typically emerge sometime between July and September, and spring-run Chinook salmon fry typically emerge from November through January in Butte and Big Chico Creeks, and from January through March in Mill and Deer Creeks (DFG 1998a). Young winter-run Chinook salmon "sac fry" remain in the gravel for an additional four to six weeks, until the yolk sac is completely absorbed (NOAA Fisheries 1997a, Myers et al. 1998). Successful incubation depends on several factors including dissolved oxygen levels, temperature, substrate size, amount of fine sediment, and water velocity. Maximum survival of incubating eggs and pre-emergent fry occurs at water temperatures between 5.6-13.3 °C with a preferred temperature of 11.1 °C. Emergence can be hindered if the interstitial spaces in the redd are not large enough to permit passage of the fry. In laboratory studies, Bjornn and Reiser (1991) observed that Chinook salmon and steelhead fry had difficulty emerging from gravel when fine sediments (6.4 mm or less) exceeded 30-40 percent by volume.

After emergence, Chinook salmon fry seek out areas behind fallen trees, back eddies, undercut banks and other areas of bank cover (Everest and Chapman 1972). As they grow larger, their habitat preferences change. Juveniles move away from stream margins and begin to use deeper water areas with slightly faster water velocities, but continue to use available cover to minimize the risk of predation and reduce energy expenditure. Optimal temperatures for both Chinook salmon fry and fingerlings range from 12-14 °C, with maximum growth rates at 12.8 °C (Boles 1988). Fish size appears to be positively correlated with water velocity and depth (Chapman and Bjornn 1969, Everest and Chapman 1972). However, Chinook salmon fry grew more quickly in the Delta (average of 0.53-0.86 mm/d) than in the Upper Sacramento River (average of 0.33 mm/d; Kjelson et al. 1982). They feed on small terrestrial and aquatic insects and aquatic crustaceans. Cover, in the form of rocks, submerged aquatic vegetation, logs, riparian vegetation, and undercut banks provide food, shade, and protect juveniles from predation.

The timing of peak downstream movement of fry can vary on an annual basis in the same system (Healey 1991). Chinook salmon fry may hold in the river before migrating seaward. Typically, downstream migration of fry in the Delta follows high flows associated with storm runoff (Kjelson et al. 1981). Generally, winter-run Chinook salmon migrate seaward from August through April. Spring-run Chinook salmon typically spend 9 to 10 months, and up to 18 months in freshwater before migrating seaward (e.g., in Deer and Mill Creeks). Some spring-run Chinook salmon can outmigrate soon after emergence during December and January, or over-summer in freshwater and outmigrate during the following fall as yearlings (e.g., in Butte and Big Chico Creeks). Some Chinook salmon fry rear in the Delta for approximately two months (Kjelson et al. 1982). However, fry that rear in the Delta have lower survival rates compared to those rearing in the Upper Sacramento River (Kjelson et al. 1982). Survival rates from fry to smolts in the Central Valley have ranged from 3 percent to 34 percent for 1980-1982 year classes (Healey 1991). Survival of smolts passing through the Delta is highly correlated with discharge of the Sacramento River.

D. Species Description of Central Valley Steelhead

In February 1994, NOAA Fisheries received a petition seeking protection under the ESA for 178 populations of steelhead in Washington, Idaho, Oregon, and California. At the time, NOAA Fisheries was conducting a status review of coastal steelhead populations in Washington, Oregon, and California (e.g., Busby et al. 1996). Following completion of a comprehensive status review of west coast steelhead populations throughout Washington, Oregon, Idaho, and California, NOAA Fisheries published a proposed rule to list 10 ESUs as threatened or endangered under the ESA on August 9, 1996. One of these steelhead ESUs, the Central Valley steelhead, was proposed for listing as an endangered species (61 FR 41541). Because of scientific disagreements, NOAA Fisheries deferred its final listing determination for five of these steelhead ESUs, including the Central Valley steelhead ESU, on August 18, 1997. After soliciting and reviewing additional information to resolve these disagreements, NOAA Fisheries published a final determination listing the Central Valley steelhead as a threatened species in March 1998 (63 FR 13347). Only naturally spawned populations of steelhead (and their progeny) residing below naturally and human-made impassable barriers (e.g., impassable waterfalls and dams) are listed. At this time, NOAA Fisheries listed only anadromous life forms of *Oncorhynchus mykiss* (i.e., not rainbow trout). Currently, NOAA Fisheries is developing a policy considering hatchery-produced fish and is reviewing the status of the Central Valley steelhead ESU.

E. Status of Stocks of Steelhead

Central Valley steelhead once ranged throughout most of the tributaries and headwaters of the Sacramento and San Joaquin basins prior to dam construction, water development, and watershed perturbations of the 19th and 20th centuries (McEwan and Jackson 1996). Steelhead counts at the RBDD declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990's, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operation.

Existing wild steelhead stocks in the Central Valley are mostly confined to upper Sacramento River and its tributaries, including Antelope, Deer, Mill Creeks, and American, Feather and

Yuba Rivers (McEwan and Jackson 1996). Naturally spawning populations are known to occur in Butte Creek, and the upper Sacramento, Feather, American, and Stanislaus Rivers (CALFED Bay-Delta Program 2000). Until recently, steelhead were thought to be extirpated from the San Joaquin River system. Recent monitoring has detected self-sustaining populations of steelhead in the Stanislaus, Mokelumne, Calaveras, and other streams previously thought to be void of steelhead (McEwan 2001). It is possible that naturally spawning populations exist in many other streams but are undetected due to lack of monitoring programs (Interagency Ecological Program Steelhead Project Work Team 1999).

F. Life History and Biological Requirements of Steelhead

Steelhead spend anywhere from one to five years in saltwater but two to three years are most common (Busby et al. 1996). Some return as "half-pounders" that over-winter one season in freshwater before returning to the ocean in the spring. The distribution of steelhead in the ocean is not well known. Coded wire tag recoveries indicate that most steelhead tend to migrate north and south along the continental shelf (Barnhart 1986).

Steelhead can be divided into two reproductive ecotypes, based on their state of sexual maturity at the time of river entry and the duration of their spawning migration: stream maturing and ocean maturing. Stream-maturing steelhead enter fresh water in a sexually immature condition and require several months to mature and spawn, whereas ocean-maturing steelhead enter fresh water with well-developed gonads and spawn shortly after river entry. These two reproductive ecotypes are more commonly referred to by their season of freshwater entry (i.e., summer [stream-maturing] and winter [ocean-maturing] steelhead). Only winter steelhead currently are found in Central Valley rivers and streams (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the Sacramento River system prior to the commencement of large-scale dam construction in the 1940's (Interagency Ecological Program Steelhead Project Work Team 1999).

Typically, adult winter steelhead migrate upstream in the Sacramento River from July through March, with peak migration in September and February (Bailey 1954, Hallock et al. 1961). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and associated lower water temperatures. The preferred temperatures for upstream migration are between 8 °C and 11 °C (Bovee 1978, Reiser and Bjornn 1979, Bell 1986). The minimum stream depth necessary for successful upstream migration is 13 cm (Thompson 1972). The preferred water velocity for upstream migration is in the range of 40-90 cm/s, with a maximum velocity, beyond which upstream migration is not likely to occur, of 240 cm/s (Thompson 1972, Smith 1973).

Steelhead may spawn more than one season before dying, in contrast to other species of the *Oncorhynchus* genus. Most spawning takes place from late December through April, with peaks from January through March (Hallock et al. 1961). Although one-time spawners are the great majority, Shapovalov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams. Among repeat spawners, the representation of each group declines as the number of spawnings increases. There is a sharp decline in numbers from second spawners (15.0 percent) to third spawners (2.1 percent). Fish spawning four or more times are rare (0.1 percent). Steelhead usually spawn in the tributaries where fish ascend as high as flows permit and may occasionally spawn in intermittent streams as well (Everest 1973, Barnhart 1986).

Upon emerging from the gravel, steelhead fry rear in edgewater habitats and move gradually into pools and riffles as they grow larger. Older fry establish territories that they defend. Cover is an important habitat component for juvenile steelhead both as velocity refuge and as a means of avoiding predation (Shirvell 1990, Meehan and Bjornn 1991). Young steelhead feed on a wide variety of aquatic and terrestrial insects, and emerging fry are sometimes preyed upon by older juveniles. In winter, they become inactive and hide in any available cover, including gravel or woody debris.

Steelhead generally spend at least two years in fresh water before emigrating downstream (Hallock et al. 1961, Hallock 1989). Rearing steelhead juveniles prefer water temperatures of 7.2-14.4 °C and have an upper lethal limit of 23.9 °C. They can survive up to 27 °C with saturated dissolved oxygen conditions and a plentiful food supply. Dissolved oxygen (DO) levels of 6.5-7.0 mg/l affected the migration and swimming performance of steelhead juveniles at all temperatures (Davis et al. 1963). Reiser and Bjornn (1979) recommended that DO concentrations remain at or near saturation levels with temporary reductions no lower than 5.0 mg/l for successful rearing of juvenile steelhead. During rearing, suspended and deposited fine sediments can directly affect salmonids by abrading and clogging gills, and indirectly cause reduced feeding, avoidance reactions, destruction of food supplies, reduced egg and alevin survival, and changed rearing habitat (Reiser and Bjornn 1979). Bell (1973) found that silt loads of less than 25 mg/l permit good rearing conditions for juvenile salmonids.

Emigrating Central Valley steelhead use the lower reaches of the Sacramento River and the Delta for rearing and as migration corridor to the ocean. Some may utilize tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas in the Delta as rearing areas for short periods prior to their final emigration to the sea. Barnhart (1986) reported that steelhead smolts in California range in size from 14 to 21 cm (fork length). Hallock et al. (1961) found that juvenile steelhead in the Sacramento Basin migrated downstream during most months of the year, but the peak period of emigration occurred in the spring, with a much smaller peak in the fall.

IV. ENVIRONMENTAL BASELINE

The environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat, and the ecosystem in the action area. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section

7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR §402.02).

The action area includes streams draining into the Sacramento and San Joaquin River Basins in the Central Valley (Figure 1). The action area encompasses approximately 43,000 square miles of the Central Valley of California, which is bounded by the Coast Range on the west and the southern Cascade and Sierra Nevada mountain ranges on the east. The Sacramento River basin (26,300 square miles) extends from the Pit River basin south through the American River basin, whereas the San Joaquin River basin (16,700 square miles) extends from the Cosumnes River basin south through the southern boundary of the San Joaquin River basin. Together, the two large river basins drain over two-thirds of the Central Valley basin before entering into the Sacramento-San Joaquin Delta to the Pacific Ocean. The action area encompasses the geographic areas included within the Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead ESUs (Figure 2).

Climate in the Central Valley is largely shaped by the mountain ranges surrounding the great basin. Summers are dry with temperatures frequently over 38 ˚C and winters are wet with temperatures dropping to below freezing. Precipitation typically falls between October and April, with the Sacramento River basin receiving nearly three times more precipitation than the San Joaquin River basin. Mean annual precipitation in the action area ranges from 12 cm to over 203 cm. Precipitation in the action area is influenced by the Sierra Nevada mountains, where approximately 50 percent of the precipitation falls as snow. The major rivers in the Central Valley have extensive spring runoff from snow melt. Average annual runoff in the Sacramento River Basin is 22.4 million acre feet and 6.4 million acre feet in the San Joaquin River Basin.

Streams within the action area flow over metamorphic and granitic rocks in the Sierra Nevada and over sedimentary rocks in the valley floor and Coast Range. Native vegetation in the action area varies from alpine and coniferous forests in higher elevations, to oak woodlands and grasslands in the lower elevations, and remnant wetlands on the valley floor.

A. Status of the Species Within the Action Area

The action area includes the entire ESUs for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead. The status of these species is described within the preceding section of this biological opinion.

B. Factors Affecting the Environment Within the Action Area

California's robust agricultural economy and the state's rapidly increasing urban growth place high demand for water in the Sacramento and San Joaquin River basins. The demand for water in the Central Valley has significantly altered the natural morphology and hydrology of the Sacramento and San Joaquin Rivers and their major tributaries. Agricultural lands and urban areas have flourished on historic floodplains. An extensive flood management system of dams, levees, and bypass channels restricts the river's natural sinuousity, volume, and reduces the lag time of water flowing through the system. An impressive network of water delivery systems have transformed the Central Valley drainage system into a series of lined conveyance channels and reservoirs that are operated by several pumping facilities. Flood management and water delivery systems, in addition to agricultural, grazing, and urban land uses, are the main anthropogenic factors affecting watersheds in the action area.

A number of documents have addressed the history of human activities, present environmental conditions, and factors contributing to the decline of salmon and steelhead species in the Central Valley (e.g., Busby et al. 1996, Myers et al. 1998, U.S. Department of the Interior 1999, CALFED Bay-Delta Program 2000). NOAA Fisheries cites many reasons (primarily anthropogenic) for the decline of Sacramento River winter-run Chinook salmon (NOAA Fisheries 1997a), Central Valley spring-run Chinook salmon (Myers et al. 1998), and Central Valley steelhead (Busby et al. 1996). The foremost reason for the decline in these anadromous salmonid populations is the degradation and/or destruction of habitat (e.g., substrate, water quality, water quantity, water temperature, water velocity, shelter, food, riparian vegetation, and migration conditions). Additional factors contributing to the decline of these populations include: commercial and recreational harvest, ocean conditions, predation, natural stochastic events, hydrographs, water quality and water quantity. Scientific research and habitat restoration activities may affect anadromous salmonid populations within the action area, but have not been specifically identified as factors contributing to the decline of these populations.

For the purposes of this document, a general description of the environmental baseline for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead is based on, in part, a summary provided in U.S. Department of the Interior (1999) and CALFED Bay-Delta Program (2000). In general, the human activities that have affected listed Central Valley anadromous salmonids and their habitats are: (1) dam construction that blocks previously accessible habitat; (2) water development activities that affect water quantity, water quality, and hydrographs; (3) land use activities such as agriculture, flood control, urban development, mining, and logging; (4) hatchery operation and practices; (5) harvest activities; (6) ecosystem restoration actions; (7) natural conditions; and (8) scientific research.

1. <u>Habitat Blockage</u>

Hydropower, flood control, and water supply dams of the Central Valley Project (CVP), State Water Project (SWP), and other municipal and private entities have permanently blocked or hindered salmonid access to historical spawning and rearing grounds. In general, large dams on every major tributary to the Sacramento River, San Joaquin River, and Delta block salmon and steelhead access to the upper portions of the respective watersheds (Figure 1). Clark (1929) estimated that originally there were 6,000 miles of salmon habitat in the Central Valley system and that 80 percent of this habitat had been lost by 1928. Yoshiyama et al. (1996) calculated that roughly 2,000 miles of salmon habitat was actually available before dam construction and mining, and concluded that 82 percent is not accessible today. Clark (1929) did not give details about his calculation. Whether Clark's or Yoshiyama's calculation is used, only remnants of their former range remain accessible today in the Central Valley (DFG 1998a).

2. Water Development Activities

Water development in the Central Valley has altered historical flow patterns in the Central Valley. Historical seasonal flow patterns included high flood flows in the winter and spring with declining flows throughout the summer and early fall. However, dams and diversion structures have dampened seasonal hydrographs and reduced the natural variability and quantity of streamflows throughout the year. The resulting changes to the seasonal hydrographs affect the timing of juvenile outmigration which are associated with flow surges. Furthermore, year round uniform flows result in diminished natural channel formations, altered foodweb processes, and regeneration of riparian vegetation. These changes to the stream channel have consequently altered and reduced salmonid habitat.

Water impoundment in upstream reservoirs reduces flows and dampens the magnitude and duration of peak flows during winter and spring. Reduced flows have contributed to higher temperatures, lower dissolved oxygen levels, and decreased recruitment of gravel and large woody debris. Instream flows during the summer and early fall months have increased over historic levels for deliveries of municipal and agricultural water supplies.

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found throughout the Central Valley. Hundreds of small and medium size water diversions exist along the Sacramento River, San Joaquin River, and their tributaries. Although efforts have been made in recent years to screen some of these diversions, many remain unscreened. Depending on the size, location, and season of operation, these unscreened intakes entrain and kill many life stages of aquatic species, including juvenile salmonids. For example, as of 1997, 98.5% of the 3,356 diversions mapped in a Geographical Information System in the Central Valley were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001).

3. Land Use Activities

Until about 150 years ago, the Sacramento River was bordered by up to 500,000 acres of riparian forest, with bands of vegetation spreading four to five miles (California Resources Agency 1989). By 1979, riparian habitat along the Sacramento River diminished to 11,000-12,000 acres or about 2 percent of historic levels (McGill 1979). More recently, about 16,000 acres of remaining riparian vegetation has been reported (McGill 1987). The degradation and fragmentation of riparian habitat has resulted mainly from flood control and bank protection projects, together with the conversion of riparian land to agriculture (Jones and Stokes Associates, Incorporated 1993).

Increased sedimentation resulting from agricultural and urban practices within the Central

Valley is a primary cause of salmonid habitat degradation. Sedimentation can adversely affect salmonids during all freshwater life stages by: clogging, or abrading gill surfaces; adhering to eggs; inducing behavioral modifications; burying eggs or alevins; scouring and filling pools and riffles; reducing primary productivity and photosynthetic activity; and affecting intergravel permeability and dissolved oxygen levels. Embedded substrates can reduce the production of juvenile salmonids and hinder the ability of some over-wintering juveniles to hide in gravel during high flow events.

Land use activities associated with road construction, urban development, logging, mining, agriculture, and recreation have significantly altered fish habitat quantity and quality through alteration of streambank and channel morphology; alteration of ambient stream water temperatures; degradation of water quality; elimination of spawning and rearing habitat; fragmentation of available habitats; elimination of downstream recruitment of gravel and large woody debris; and removal of riparian vegetation resulting in increased streambank erosion. Agricultural practices have eliminated large trees and logs and other woody debris that would have been otherwise recruited to the stream channel. Large woody debris influences stream morphology by affecting pool formation, channel pattern and position, and channel geometry.

Historically in the Delta, tidal marshes provided a highly productive estuarine environment for juvenile anadromous salmonids. During the course of their downstream migration, juvenile winter-run Chinook salmon, spring-run Chinook salmon, and steelhead use the Delta's estuarine habitat for seasonal rearing, and as a migration corridor to the sea. Since the 1850's, reclamation of Delta islands for agricultural purposes caused the cumulative loss of 94 percent of the Delta's tidal marshes (Association for Bay Area Governments 1992).

In addition to the degradation and loss of estuarine habitat, downstream migrant juvenile salmon in the Delta have been subject to adverse conditions created by water export operations of the CVP and SWP. Specifically, juvenile salmon have been adversely affected by: (1) water diversion from the mainstem Sacramento River into the Central Delta via the manmade Delta Cross Channel; (2) upstream or reverse flows of water in the lower San Joaquin River and southern Delta waterways; and (3) entrainment and mortality at the CVP/SWP export facilities and associated problems at Clifton Court Forebay. Juvenile salmonids are exposed to increased water temperatures in the Delta during the late spring and summer due to the loss of riparian shading, and by thermal inputs from municipal, industrial, and agricultural discharges.

4. Hatchery Operation and Practices

Five hatcheries currently produce Chinook salmon in the Central Valley and four of these also produce steelhead. Releasing large numbers of hatchery fish can pose a threat to wild Chinook salmon and steelhead stocks through genetic impacts, competition for food and other resources between hatchery and wild fish, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production (Waples 1991). The genetic impacts of artificial propagation programs in the Central Valley are primarily caused by the straying of hatchery fish and the subsequent hybridization of hatchery and wild fish. In the Central Valley, practices such as trucking smolts to distant sites for release and the transferring of eggs between hatcheries contribute to elevated straying levels (U.S. Department of the Interior 1999).

5. Harvest

The ocean salmon fisheries in the exclusive economic zone off Washington, Oregon, and California are managed by NOAA Fisheries under authority of the Magnuson-Stevens Fishery Conservation and Management Act. Management measures are developed according to the Pacific Coast Salmon Plan (FMP) and implemented by NOAA Fisheries if they are found to be consistent with the Magnuson-Stevens Act and other applicable law, including the ESA. The Secretary of Commerce, acting through NOAA Fisheries, has the ultimate authority for the FMP and its implementation; NOAA Fisheries is therefore both the action agency and the consulting agency in the section 7 consultation required under the ESA, and NOAA Fisheries issues the associated incidental take permit to itself.

Ocean salmon fisheries off California are managed to meet the conservation objectives for certain stocks of salmon listed in the FMP, including any stock that is listed as threatened or endangered under the ESA. FMP objectives exist for some ESA listed stocks, but for others, including Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon, the FMP objective is the Reasonable and Prudent Alternative of NOAA Fisheries' biological opinion on implementation of the FMP. Through a series of section 7 consultations on ocean fisheries managed under the FMP (NOAA Fisheries 1996, 1997b, 2000, 2002), NOAA Fisheries has taken measures to reduce the impacts of commercial and recreational fisheries on Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon to levels that are consistent with recovery of the populations.

To address potential incidental take of Chinook salmon that occurs in the recreational trout fishery, the California Fish and Game Commission adopted in 1992 gear restrictions (all hooks must be barbless and a maximum 5.7 cm in length) to minimize hooking injury and mortality caused by trout anglers incidentally catching winter-run Chinook salmon. Specific regulations for the protection of spring-run Chinook salmon in Mill, Deer, Big Chico, and Butte Creeks were added to the existing DFG regulations in 1994. Existing regulations, including those developed for winter-run Chinook salmon provide some level of protection for spring-run fish (DFG 1998a).

There is no commercial harvest of Central Valley steelhead. All wild steelhead caught in California must be released unharmed except in the Smith River (DFG 2003a). Limited information exists on steelhead recreational harvest rates in California.

6. Ecosystem Restoration

Restoration activities may cause temporary increases in turbidity and alter channel dynamics and stability (Habersack and Nachtnebel 1995, Hilderbrand et al. 1997, Powell 1997, Hilderbrand et al. 1998); these effects may temporarily stress salmonids. Misguided restoration efforts often fail to produce the intended benefits and can even result in further habitat degradation. Improperly constructed projects typically cause greater adverse effects than the pre-existing condition. The most common reason for this is improper identification of the design flow for the existing channel conditions. However, properly constructed stream restoration projects may increase available habitat, habitat complexity, stabilize channels and streambanks, increase spawning gravels, decrease sedimentation, and increase shade and cover for salmonids. DFG has produced a manual for stream restoration projects in California (see DFG 1998b, 2003b) providing guidance to maximize benefit to salmonids while minimizing risks. The negative effects of habitat restoration activities on anadromous salmonid populations within the action area are generally temporary and minor. Overall, properly designed and implemented habitat restoration projects are considered to be beneficial to the restoration and recovery of at risk populations.

Significant steps towards the largest ecological restoration project yet undertaken in the United States have occurred during the past several years and continue to proceed in California's Central Valley. The CALFED Bay-Delta Program, in coordination with other Central Valley efforts including those implemented through the Central Valley Project Improvement Act, has implemented numerous habitat restoration actions that benefit Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and critical habitat for Sacramento River winter-run Chinook salmon. These restoration actions include the installation of fish screens, modification of barriers to improve fish passage, and habitat acquisition and restoration. The majority of these recent restoration actions address key factors for decline of these ESUs and emphasis has been placed in tributary drainages with high potential for winter-run Chinook salmon, spring-run Chinook salmon, and steelhead production. Additional actions that are currently underway that benefit Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead include new efforts to enhance fisheries monitoring and conservation actions to address artificial propagation.

A beneficial action unrelated to the CALFED Program includes the Environmental Protection Agency's remedial actions at Iron Mountain Mine. The completion of a state-of-the-art lime neutralization plant is successfully removing significant concentrations of toxic metals in acidic mine drainage from the Spring Creek Watershed. Containment loading into the upper Sacramento River from Iron Mountain Mine has shown measurable reductions since the early 1990's.

7. Natural Conditions

Natural changes in the freshwater and marine environments play a major role in salmonid abundance. Recent evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Hare et al. 1999, Mantua and Hare 2002). This phenomenon has been referred to as the Pacific Decadal Oscillation. In addition, large-scale climatic regime shifts, such as El Niño, appear to change ocean productivity. During the first part of the 1990's, much of the Pacific Coast was subject to a series of very dry years.

A key factor affecting many West Coast stocks has been a general 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood, partially because the pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. It is presumed that survival is driven largely by events occurring between ocean entry and recruitment to a subadult life stage. One indicator of early ocean survival can be computed as a ratio of coded-wire tag (CWT) recoveries from subadults relative to the number of CWTs released from that brood year.

Salmon and steelhead are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Ocean predation may also contribute to significant natural mortality, although it is not known to what degree. In general, salmonids are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that the rebound of seal and sea lion populations—following their protection under the Marine Mammal Protection Act of 1972—has caused a substantial number of salmonid deaths.

Finally, it should be noted that the unusual drought conditions in 2001 warrant additional consideration. Flows in 2001 were among the lowest flow conditions on record. The available water in the Sacramento watershed and San Joaquin watershed was 70 percent and 66 percent of normal, according to the Sacramento River Index and the San Joaquin River Index, respectively. The juveniles that passed downriver during the 2001 spring and summer out-migration likely were affected and this, in turn, may affect adult returns primarily in 2003 and 2004, depending on the stock and species. At this time, it is impossible to ascertain what those effects will be, but NOAA Fisheries is monitoring the situation and will take the drought condition into account in management decisions, including amending take authorizations and other permit conditions as needed.

8. Scientific Research

Most biological opinions that NOAA Fisheries issues require specific monitoring, evaluation, and research efforts intended to help gather information that would be used to increase the survival of affected listed fish. In general, permit holders and applicants provide NOAA Fisheries with high take estimates to compensate for potential in-season changes in research protocols, accidental catastrophic events, and the annual variability in listed fish numbers. Also, most research projects depend on annual funding and the availability of other resources. So, a specific research project, for which take of ESA-listed species is authorized by a permit, may be suspended in a year when funding or resources are not available. As a result, the actual take in a given year for most research projects, as provided to NOAA Fisheries in post-season annual reports, is usually less than the authorized level of take in the permits and the related NOAA Fisheries consultation on the issuance of those permits.

Despite the fact that fish are harassed and even killed in the course of scientific research, only a small fraction of available habitat is sampled; therefore, only a small proportion of the total population is subject to sampling and the loss to the total population is small (McMichael et al. 1998). While threats to listed species vary among sites and populations, altered habitat and water regimes and exotic species are the primary factors affecting native fish fauna (Richter et al. 1997, Wilcove et al. 1998).

Currently, NOAA Fisheries is compiling and synthesizing research results submitted in annual reports by permitted researchers in an effort to identify harmful and beneficial impacts of permitted research activities on ESA-listed salmonids. Research activities have a great potential to benefit ESA-listed salmon and steelhead. For example, permitted scientific research can provide data useful for the management and recovery of listed species. Aside from simply increasing what is known about the listed species and their biological requirements, research is essentially the only way to answer key questions associated with difficult resource issues that involve every salmonid life history stage. Further, there is no way to tell if the corrective measures described in the previous sections are working unless they are monitored and no way to design new and better corrective measures if research is not done. The information gained during research and monitoring activities will help resource managers recover listed species. The annual reauthorization of any section 10(a)(1)(A) permit is contingent upon receipt and approval of an annual report containing data on the preceding reporting period's research activities, a description of accomplished research activities, and a description of activities proposed for the forthcoming reporting period. In addition, all permit holders must submit a final report within ninety (90) days of the expiration of their permit summarizing the results of the research and the success of the research relative to its goals.

NOAA Fisheries does not consider scientific research and monitoring efforts (unlike the other factors described in the previous sections) to be a factor contributing to the decline of anadromous salmonids within the action area, and NOAA Fisheries believes that the information derived from the research activities is essential to their survival and recovery. Nonetheless, fish are harmed during research activities. And activities that are carried out in a careless or undirected fashion are not likely to benefit the species at all. Therefore, to minimize any harm arising from research activities on the species, NOAA Fisheries imposes conditions in its permits so that permit holders conduct their activities in such a way as to reduce adverse effects -- particularly killing as few salmonids as possible. Also, researchers are encouraged to use nonlisted fish species and hatchery fish in experiments instead of listed naturally-produced fish. In addition, researchers are required to share fish samples, as well as the results of the scientific research, with other researchers and co-managers in the region as a way to avoid duplicative research efforts and to acquire as much information as possible from the ESA-listed fish sampled. NOAA Fisheries also works with other agencies to coordinate research and thereby prevent duplication of effort.

V. EFFECTS OF THE PROPOSED ACTION

The purpose of this section is to identify effects associated with NOAA Fisheries' issuance of scientific research permits on ESA-listed salmonids within the action area. In each individual research permit, NOAA Fisheries will describe special conditions and operating requirements to minimize the effects of the project on ESA-listed salmonids (also see subsection D below). The primary effects of the proposed research activities on ESA-listed salmonids are expected to be related to harassment associated with intentional take. Harassment generally leads to stress and other sub-lethal effects and is caused by observing, capturing, and handling fish. Unintentional mortality may occur during handling or after the fish has been released. Based on prior experience with the research techniques and protocols that would be used to conduct the proposed scientific research, no more than five percent of the juvenile salmonids encountered are likely to be killed as an indirect result of being captured and handled and, in most cases, this lethal take will not exceed three percent. NOAA Fisheries expects that less than one percent of the adults handled will die.

In the first subsection below we will describe effects associated with direct observation techniques – techniques that are the least likely to harm ESA-listed species. In the subsequent subsections we describe general effects associated with specimen handling, followed by additional collection-gear specific effects.

A. Effects Associated with Direct Observation

Provided that visibility and other conditions are sufficient, direct observation is used to gather important data on habitat utilization, behavior, distribution, and for estimating population size and structure. Direct observation can entail walking the side of the water body, or underwater observation techniques such as snorkeling, scuba diving, and video photography. Observing fish by walking the side of the water body is done only on small bodies of water or the littoral zones of large bodies of water. Underwater observation is most frequently used in small lakes, streams, and tidepools, however, can be undertaken efficiently in large, deep water bodies (e.g., oceans, rivers, and reservoirs) provided that conditions are adequate (Dolloff et al. 1996). Turbidity, turbulence, target species behavior, habitat structure and complexity, hydrology, ambient light, and, perhaps, weather affect the efficiency of direct observation.

Another type of direct observation involves spawning surveys. In these surveys the observer walks directly in the stream during spawning season, as close to the edge as possible, locating redds and carcasses. These surveys usually involve the concurrent observation and notation of spawning salmonids as well. Salmonid carcasses are measured, the sex is determined, and scale and tissue samples are usually collected. Redds are usually flagged and the locations recorded. One of the effects of this type of survey is the possible disturbance of redds if the observer accidentally steps on one. If spawning salmonids are present during these surveys then the fish can be unintentionally frightened off by the observer, disrupting their spawning activities or their effort to guard the redd after spawning.

Direct observation is the least intrusive method for determining presence/absence of the species and estimating their relative abundance. Effects of direct observation are generally the shortestlived among any of the research activities discussed in this section. Videography should induce no effects on ESA-listed fish. Using other forms of direct observations, a cautious observer can effectively obtain data without disrupting the normal behavior of a fish.

There is no evidence that fish are injured by direct observations. Observations made by State and Federal fishery biologists counting Chinook salmon and steelhead in Central Valley streams indicate that direct observation does not cause any behavioral effects that prevent salmon and steelhead from successfully holding, spawning, or feeding (Paul Ward, DFG, personal communication 2002, Sarah Giovannetti, U.S. Fish and Wildlife Service, personal communication 2003). Snorkeling surveys may frighten adult and juvenile spring-run Chinook salmon and steelhead, which may cause the fish to seek temporary refuge behind rocks, vegetation, and deep water areas. Frightened juveniles return to feeding habitats, and adults return to holding and spawning habitats within seconds after the observer passes through the habitat unit. In some cases, salmon may temporarily leave the particular pool or habitat type when observers are in their area. Adult mortalities do not occur because snorkel encounters with Chinook salmon are brief and do not involve any physical contact. Researchers minimize the amount of disturbance by limiting the number of times that each habitat unit is snorkeled and by moving through areas deliberately and without unnecessary, abrupt, or erratic body movements.

B. Effects Associated with General Capture and Handling

Capturing and handling fish causes them stress, though they typically recover fairly rapidly from the process and, therefore, the overall effects of the handling are generally short-lived. The primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the original habitat and the container in which the fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma (Kelsch and Shields 1996). Stress on salmonids increases rapidly from handling if the water temperature exceeds 18 °C or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process. In addition, when fish are handled by samplers to obtain measurements and other data, it is not uncommon for fish to be dropped on the ground by the handlers because the fish are not sedated enough or properly restrained. This can result in internal injuries, especially in females with developing ovaries (Stickney 1983). An injured fish is more susceptible to developing diseases, which can lead to delayed mortality. Some of the injuries which can lead to disease are the loss of mucus, loss of scales, damage to integument and internal damage (Stickney 1983, Kelsch and Shields 1996). In addition to the risks associated with handling, all fish handled will be exposed to additional risks specific to the various methods of capture described in the following subsection.

C. Collection Gear Specific Effects

Following are descriptions of effects of different capture methods and their associated collection gears. The types of gear are described briefly in the following subsections, for more detailed descriptions, see relevant chapters in Nielsen and Johnson (1983) and Murphy and Willis (1996). NOAA Fisheries imposes special conditions and operating requirements in individual research permits to minimize harm to fish resulting from specific data collection techniques described below.

1. Tagging and Marking

The use of passive integrated transponder (PIT) tags, coded wire tags (CWT), fin-clips, and biotelemetry transmitters are common to many scientific research efforts using ESA-listed species. Some tags or marks allow biologists to identify groups of fish (e.g., hatchery-produced fish or test fish) and some allow for the identification of individual fish. All sampling, handling, and tagging procedures have an inherent potential to stress, injure, or even kill the marked fish.

a. *PIT Tags*

A PIT tag is an electronic device that relays signals to a receiver; it allows individual fish to be identified whenever they pass a location containing such a receiver (e.g., some fish ladders) without researchers having to handle the fish. The tag is inserted into the body cavity of the fish using a modified hypodermic needle, typically, just in front of the pelvic girdle. The insertion of PIT tags requires that the fish be captured and extensively handled, therefore the fish can be affected by any or all of the associated risks mentioned in the section on capture and handling methods. PIT tags have very little effect on growth, survival, swimming speed, stamina, or behavior (Jenkins and Smith 1990, Prentice et al. 1990, Prentice et al. 1994).

b. *Coded Wire Tags*

Coded wire tags are made of magnetized, stainless-steel wire. They bear distinctive notches that can be coded for such data as species, brood year, and hatchery of origin (Nielsen 1992). The tags are intended to remain within the animal indefinitely, consequently making them ideal for long-term, population-level assessments of Pacific salmon. In salmon, CWTs are injected into the nasal cartilage and, therefore, cause little direct tissue damage (Bergman et al. 1968). A major advantage to using CWTs is that external and internal tissue damage from the tag and injections heals rapidly and is minor (Bergman et al. 1968, Fletcher et al. 1987, Buckley and Blankenship 1990). In order for researchers to be able to determine later (after the initial tagging) which fish possess CWTs, it is necessary to mark the fish externally—usually by clipping the adipose fin—when the CWT is implanted (see text below for information on fin clipping). One major disadvantage to recovering data from CWTs is that the fish must be killed in order for the tag to be removed. However, this is not a significant problem for the salmonid population because researchers generally recover CWTs from salmon that have been taken during the course of commercial and recreational harvest, or post-spawning carcass surveys.

c. *Biotelemetry Tags*

Biotelemetry tags (or radio tags) are implanted transmitters which allow one to identify and follow an individual fish continuously and remotely and to gather information on migration and habitat utilization. There are two main ways to implant a tag and they differ in both their characteristics and consequences. The first method of implanting a tag is to slip it into the fish's stomach through the esophagus. Stomach insertion does not cause a wound and does not interfere with swimming. This technique is benign when salmon are in the portion of their spawning migrations during which they do not feed (Nielsen 1992). In addition, for short-term studies, stomach tags allow faster post-tagging recovery and interfere less with normal behavior than do tags attached in other ways. A second common method for implanting a tag is to surgically implant the tag within the body cavity. These tags generally do not interfere with feeding or movement, though the size of the tag and fish do influence effects. However, the surgical procedure is difficult, requiring considerable experience and equipment (Summerfelt and Smith 1990, Nielsen 1992). Because the tag is placed within the body cavity, the tag may injure a fish's internal organs. An improperly positioned incision may cause serious injury to the fish. Also, infections of the sutured incision and the body cavity itself are also possible, especially if the tag and incision are not treated with antibiotics (Chisholm and Hubert 1985, Mellas and Haynes 1985, Summerfelt and Smith 1990). Fish with internal radio tags often die at higher rates than fish tagged by other means because radio tagging is a complicated and stressful process. Mortality is both acute (occurring during or soon after tagging) and delayed (occurring long after the fish have been released into the environment). Acute mortality is caused by trauma induced during capture, tagging, and release. It can be reduced by handling fish as gently as possible. Delayed mortality occurs if the tag or the tagging procedure harms the animal in direct or subtle ways. Tags may cause wounds that do not heal properly, may make swimming more difficult, or may make tagged animals more vulnerable to predation (Howe and Hoyt 1982, Matthews and Reavis 1990, Moring 1990). Tagging may also reduce fish growth by increasing the energetic costs of swimming and maintaining balance.

d. *Fin Clipping*

Fin clipping is the process of removing part or all of one or more fins to alter a fish's appearance and thus make it identifiable. When entire fins are removed, it is expected that they will never grow back. Alternatively, a permanent mark can be made when only a part of the fin is removed or the end of a fin or a few fin rays are clipped. Although researchers have used all fins for marking at one time or another, the current preference is to clip the adipose, pelvic, or pectoral fins.

Many studies have examined the effects of fin clips on fish growth, survival, and behavior. The results of these studies are somewhat variable; however, it appears that fin clips do not generally alter fish growth. Moreover, wounds caused by fin clipping usually heal quickly, especially those caused by partial clips. Mortality among fin-clipped fish is also variable (Duke 1986). Some immediate mortality may occur during the process, especially if fish have been handled extensively for other purposes (e.g., stomach sampling). Mortality depends on species and ambient conditions. Also, small fishes are more sensitive to handling; Coble (1967) suggested that fish shorter than 90 mm are at particular risk. The degree of mortality among individual fishes also depends on which fin is clipped. Mortality is generally higher when the major median and pectoral fins are clipped. By convention, an adipose mark has significance in California and implies that a fish has been implanted with a coded-wire tag.

2. <u>Hoop Nets</u>

Hoop nets are cylindrical or conical nets that are distended by a series of hoops or frames covered by web netting. A hoop net has one or more internal funnel shaped throats that are directed inward from the mouth of the net. The throats direct and trap the fish in the back end (codend) of the net. The net is held in place by ropes, weights, or stakes. Hoop nets are typically used in lakes and reservoirs, but are sometime used in river habitats. To increase capture efficiency of highly migratory fish, some hoop nets are set with "wings" of netting attached to the mouth of the net. The wings intercept migrating fish and direct them into the mouth of the net. Typically, fish are removed from hoop nets by scooping the fish out of the internal compartments using a dip net. Hoop nets are most effective for species that are attracted to cover, or other fish, or that are intercepted by the wings. Net construction (size and materials) and placement influence efficiency of hoop nets. Fish captured with hoop nets are generally captured unharmed, though there are some risks associated with hoop nets: small fish can be "gilled" in the netting, captured fish are subject to crowding and in-net predation from other fish, or injury by removal of the fish by dip net.

3. <u>Seines</u>

A seine is a net that traps fish by encircling them with a long wall of webbing. Typically, the top edge of a seine has floats, the bottom edge is weighted, and the seine has a brail (wooden pole) on each end. As the net is closed the fish become concentrated in the net. Seines are usually large enough that they are fished by two or more people, though can be small enough to be fished by one person. Generally, seines are set in an arc around the targeted fish and then dragged to shore. Seines are effective for sampling littoral areas of lentic habitats. In lotic habitats, seines are most easily used in areas of low velocity, but can be used in high velocity areas if the brails are held in place while someone approaches the net from upstream, herding fish into the net. To be most effective, a seine needs to be deployed quickly enough that the target species cannot escape the encircling net. Accordingly, habitat structure and complexity negatively influence seine efficiency by reducing the speed at which one deploys a seine and by offering escape cover. Small fish can be gilled in the mesh of a seine. Scales and dermal mucus can be abraded by contacting the net. Fish can be suffocated if they are not quickly removed from the net after the net is removed from the water to process the fish. Also, the fish can be crushed by the handler when removing the net from the water.

4. <u>Trawls</u>

Trawls are cone-shaped, mesh nets that are towed, typically, along benthic habitat (Hayes 1983, Hayes et al. 1996). Rectangular doors, attached to the towing cables, keep the mouth of the trawl open. Most trawls are towed behind a boat, but small trawls can be operated by hand. As fish enter the trawl, they tire and fall to the codend of the trawl. Mortality and injury rates associated with trawls can be high, particularly for small or fragile fish. Fish can be crushed by debris or other fish caught in the net. Depending on mesh size, some small fish are able to escape the trawl through the netting. However, not all fish that escape the trawl are uninjured, as fish may be damaged while passing through the netting. Short duration trawl hauls (5 to 10 minutes maximum) may reduce injuries (Hayes 1983, Stickney 1983, Hayes et al. 1996).

5. Hook and Line

The use of hook and line (angling) is typically associated with recreational or commercial fishing, but can be used for collecting research samples (Hayes et al. 1996). Angling can target specific species or size of fish. Angling has been used in scientific studies for a variety of research activities including conducting radiotelemetry studies, studies of fish genetics, fish mortality and fish population structure and abundance. Another form of hook and line capture is a trotline. A trotline has a main line strung horizontally with short vertical lines (drop lines) attached to it (Hubert 1996). Each of the vertical lines has a baited hook attached to it. Trotlines are used frequently in warmwater inland fisheries and are generally used to capture catfish or common carp. Hook and line captures exercise size selectivity and extreme variability in catch rates. Injuries related to hook and line capture are influenced by hook size and type, bait or lure choice, and species behavior. Common hook and line injuries include damage to the skeletal structure of the mouth, injury to gills, and secondary infections.

6. Electrofisher

Electrofishing is a process by which an electrical current is passed through water in order to stun fish and facilitate capture. It can also be used to guide or block their movements. There are three general systems for electrofishing related to where the electrical generator is maintained: backpack, boat, and shore. Backpack electrofishing is the most common system used for salmonids. Boat and shore electrofishing units often use more current than backpack electrofishing equipment because they are used to cover larger (and deeper) areas and, as a result, potentially have a greater impact on fish. This biological opinion considers only backpack electrofishing.

Two or three technicians work together while backpack electrofishing. One person carries the backpack and searches the target habitats with the anode, while one or two others net stunned fish. Operators work in teams to increase the number of fish that may be seen or captured. Working in teams also allows the researcher to net fish before they are subjected to higher electrical fields.

The use of electricity to capture fish is one of the most intrusive and risky methods. This method of capture can result in a variety of effects from simple harassment to injury to the fish (adults and juveniles) and death. There are two major forms of injuries from electrofishing; hemorrhages in soft tissues and fractures in hard tissues. Only a few recent studies have examined the long-term effects of electrofishing on salmonid survival and growth (Dalbey et al. 1996, Ainslie et al. 1998). These studies indicate that although some of the fish suffer spinal injury, few die as a result. Dalbey et al. (1996), reports that the growth of rainbow trout was markedly lower when there was moderate to severe electrofisher induced spinal injury. Electrofishing can also result in trauma to fish from stress. The stress caused by electrofishing is usually not recognized because the fish often appear normal upon release. Recovery from this stress can take up to several days, and during this time the fish are more vulnerable to predation, and less able to compete for resources. Stress related deaths can also occur within minutes or hours of release, with respiratory failure usually the cause.

The waveform produced by the electrofisher affects injury potential. Continuous direct current or low-frequency (£30 Hz) pulsed direct current have been recommended for electrofishing (Fredenberg 1992, Snyder 1992, Snyder 1995, Dalbey et al. 1996) because lower spinal injury rates, particularly in salmonids, occur with these waveforms (Fredenberg 1992, McMichael 1993, Sharber et al. 1994, Dalbey et al. 1996).

The age or stage of development of the target species affects injury rates too. Electrofishing can have severe effects on adult salmonids, particularly spinal injuries from forced muscle contraction. Sharber and Carothers (1988) reported that electrofishing killed 50 percent of the adult rainbow trout in their study. The relatively few studies that have been conducted on juvenile salmonids indicate that spinal injury rates are substantially lower than they are for large fish. Smaller fish intercept a smaller head-to-tail potential than larger fish (Sharber and Carothers 1988) and may therefore be subject to lower injury rates (e.g., Hollender and Carline 1994, Dalbey et al. 1996, Thompson et al. 1997). McMichael et al. (1998) found a 5.1 percent injury rate for juvenile steelhead captured by electrofishing in the Yakima River subbasin. Cho et al. (2002) showed that electrofishing has dramatic negative effect on survival of eggs from electroshocked females (up to 93 percent mortality) and eggs electrofished post spawning (up to 34 percent mortality). To minimize harm to fish, NOAA Fisheries requires researchers to follow NOAA Fisheries' electrofishing guidelines (see Appendix A). For example, NOAA Fisheries prohibits electrofishing near spawning adults or active redds.

7. <u>Cast Nets</u>

Cast nets are circular nets with weighted edges. Cast nets are thrown to deploy; the net lands on the surface and sinks rapidly entrapping the fish. Cast nets have a central line that allows the net to be pursed and pulled in. Proper deployment of a cast net requires practice, as it is difficult to throw the net and have it land flat on the water. But once the technique is learned, cast nets are quick and efficient methods for collecting fish. Cast nets are useful in areas that have water free of plants, or rocks, and that have a flat bottom. Small fish caught in cast nets can be gilled. Scales and mucus can be abraded by the net.

8. <u>Dip Nets</u>

Dip nets are bag shaped nets on a frame attached to a handle. The net is placed under the fish and then lifted from the water in a scooping motion. Dip nets are useful when collecting fish that have been trapped by other methods, such as electrofishing or trap nets. Scales and mucus can be abraded by the net, and fish can be crushed by the frame when the handler is attempting to catch them.

9. Gill Nets

Gill nets are walls of netting suspended vertically in the water by a float line on the top and lead line on the bottom. The mesh of gill nets is relatively large; fish attempt to pass through the mesh and are captured. Fish are caught in the net in one of three ways: (1) gilled – held by mesh slipping behind the opercula, (2) wedged – held by the mesh around the body, or (3) tangled – held by teeth, spines, maxillaries or other protrusions without penetration of the mesh (Nielsen and Johnson 1983). Fish are primarily caught in the net by being gilled. When a fish is gilled the opercula do not open and close efficiently and disrupt respiratory gas exchange, leading to suffocation. Sometimes fish are injured while being removed from a gill net, including damage to internal organs from being squeezed, damage to scales and mucus, and damage to jaws and other protruding segments of the body. Soak time proportionally affects the lethal nature of gill nets (Hubert 1983, Hubert 1996); therefore, use of short-length gill nets that are checked frequently should reduce injury. Since gill nets are highly lethal and stress fish more than other forms of passive gears (Hubert 1996), gill nets should not be the preferred gear for capturing live fish for release.

10. Trammel Nets

Trammel nets are entanglement nets similar to gill nets. They typically consist of several parallel panels of netting which are suspended vertically from a single float line and attached to a single lead line. A fish will swim through a larger mesh opening and hit the smaller mesh section. The fish will then push the smaller mesh panel through an opening in the opposite larger mesh panel creating a pocket of mesh that entangles the fish. A major benefit of trammel nets over gill nets is that most fish captured in a trammel net are in generally better condition than fish captured in gill nets (Hubert 1983, Hubert 1996). Small fish can get gilled in the inner netting.

11. Traps

There are several common types of traps used to catch fish (e.g., fyke traps, screw traps, and pot gears). Fyke nets also are known as wing nets, frame nets, trap nets, and hoop nets (Hubert 1996). These nets generally are used in shallow waters of lakes and reservoirs, but they can also be used in deep water and in streams with slow currents. Modified fyke nets have frames across them near the mouth for stabilization. Fyke nets have leads or wings of webbing attached to the mouth to guide fish into the enclosure. Fish will swim into the enclosure as they follow the lead or wing in an attempt to get around the netting. Fish captured with fyke and trap nets are less stressed than fish captured with entanglement gears and are usually released unharmed. However, the use of these nets can cause abrasion to fish from shaking fish down into the cod end prior to removal. Furthermore, these nets can result in mortality when small fish are gilled in the mesh of the nets.

Screw traps are used in rivers of medium flow to capture fish as they travel downstream. They are large cones attached to a catamaran. Screw traps are manufactured in various diameters (approximately 3-5 feet), and are placed horizontally in the stream bed with the open end of the cone facing upstream. Half of the open end of the cone is above the water. The fish enter the open end and proceed through a corkscrew in the downstream end of the trap. At the end of the corkscrew is a box for live capture, which will hold the fish. The purpose of the corkscrew is to prevent the fish from escaping out the open funnel end of the trap.

Pot gears are traps that are portable and rigid, with small openings for animals to enter and are usually small enough to be carried by hand (Hubert 1996). They are typically weighted with stones and marked by a buoy. Some examples of typical pot gears are lobster pots, minnow traps, slat traps for catfish, eel pots and crab pots. These traps are used to capture fish and crustaceans and are most efficient at capturing bottom-dwelling species seeking food or shelter. Fish are captured in the trap when they pass through a conical shaped funnel to reach a receptacle containing bait. One of the risks associated with the use of pot gears is that the gear can continue to capture animals if it is lost, a process called ghost fishing. Fish caught in the various types of pot traps can be crushed by in-trap weight.

Fish caught in traps experience stress and injury from overcrowding if the traps are not emptied on a regular basis. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis. Fish caught in traps are vulnerable to in-trap predation by other fish and to predation by mammals, birds, or reptiles that are able to enter the trap.

12. Gastric Lavage

Information on fish diet may be useful in endangered species management. A significant component of diet studies is to know the content of a fish's stomach; the simplest and most primitive method is to kill the fish, surgically remove its stomach, and describe the stomach contents. However, sacrificing ESA-listed fish for diet analyses is not acceptable. Fortunately, there are several nonlethal methods available for determining the diet of listed fish. Most times gastric evacuation entails inserting a tube through the esophagus to the stomach of a fish and then flushing the stomach contents. Alternative methods include the use of emetics, vacuuming the stomach, the use of forceps, or flushing the anus. Kamler and Pope (2001) reviewed several gastric evacuation methods and found that most procedures were relatively safe and effective at removing stomach contents. Some risks associated with gastric lavage include: increased handling time and associated stress; injury to the soft tissues of the esophagus, stomach, or intestine; and, with some techniques, injury to the jaws and anesthetic-related injury. Most reported levels of injury are quite low, frequently zero (reviewed in Kamler and Pope 2001), but Sprague et al. (1993) reported 33 percent mortality in juvenile white sturgeon (*Acipenser* *transmontanus*) and Hartleb and Moring (1995) reported mortality of 60 percent in golden shiner (*Notemigonus crysoleucas*). Haley (1998), however, showed that mortality in juvenile sturgeon could be greatly reduced by using smaller, more ductile tubing than used by Sprague et al. (1993), and by anesthetizing test fish. Gastric lavage has been used safely, and effectively in salmonids (Kamler and Pope 2001). Meehan and Miller (1978) reported 10-15 percent mortality (after 30 days) in coho salmon (*O. kisutch*) that were collected by electrofisher, subjected to gastric lavage, transferred to a laboratory, and held 30 days; it is not possible to determine which factor had the greatest influence on survival.

D. Measures to Reduce the Impacts of the Research Program

Implementation of resulting permits will take ESA-listed salmonids and result in adverse impacts to a number of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead. To minimize the effect of take on ESA-listed salmonids during the research activities that will follow issuance of research permits, NOAA Fisheries shall review each application to ensure that the amount of take proposed is commensurate with the status of the subpopulation of Chinook salmon and steelhead affected by the action. In accordance with 50 CFR §222.308(c), NOAA Fisheries will issue permits only for activities that will benefit the recovery of the species. NOAA Fisheries shall require permit applicants to provide a clear description of the purposes and methods of the requested activities to ensure that such activities would further the recovery of Chinook salmon and steelhead, and to estimate the form and extent of take that may result from such actions. Before issuing a section 10(a)(1)(A) permit under this opinion, NOAA Fisheries will prepare a memorandum which will analyze the expected effects of implementing the proposed action and will tier to this biological opinion when appropriate.

Permits will be issued based on a prioritized research system. Recently NOAA Fisheries published take prohibitions for several West Coast salmonids (65 FR 42422, 67 FR 1116) highlighting the value of research to the recovery process and acknowledging the lack of available research data. Dr. Steve Lindley, Ecologist at NOAA Fisheries Southwest Fisheries Science Center, has identified types of research needed to address recovery issues for Central Valley salmonids (Table 2; personal communication).

NOAA Fisheries shall review the credentials of all applicants for the section 10(a)(1)(A) permits to ensure that only qualified individuals will sample or direct research efforts. Applicants are considered qualified if they can provide evidence of experience working with Chinook salmon and steelhead, or possibly other salmonids. Individuals not qualified will be required to work under the direct, on-site supervision of a qualified individual. The Permit Holder will ensure that all persons operating under their permit will be familiar with the terms and conditions of the permit. Also, the Permit Holder will insure that all persons operating under their permit will be properly trained and have access to properly maintained state-of-the-art equipment.

NOAA Fisheries has developed guidelines for the use of backpack electrofishing (Appendix A) and will require that all Permit Holders follow the guidelines. Electrofishing in the vicinity of adult ESA-listed salmonids or redds of ESA-listed salmonids will not be allowed under this programmatic biological opinion.

NOAA Fisheries will include special nondiscretionary terms and conditions to each section 10(a)(1)(A) permit issued for intentional take of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead. NOAA Fisheries believes that the permit conditions are necessary and appropriate to minimize take and the effect of take on ESA-listed salmonids. NOAA Fisheries has developed general permit conditions common to all permits (Appendix B) and will develop project-specific permit conditions for each permit. Adherence to the general permit conditions set forth in Appendix B, and the forthcoming project-specific conditions, will serve to minimize the impacts of taking listed salmonids.

Finally, NOAA Fisheries will monitor actual annual takes of ESA-listed fish species associated with scientific research activities (as provided to NOAA Fisheries in annual reports or by other means) and shall adjust annual permitted take levels if they are deemed to be excessive or if cumulative take levels are determined to operate to the disadvantage of the ESA-listed species.

E. Beneficial Effects of Issuing Research or Enhancement Permits

There must be an obvious benefit to the species in order to consider authorizing the intentional capture of ESA-listed species and potential removal of those individuals from the population. The use of ESA-listed species for scientific research is consistent with the purpose of the ESA when the research facilitates recovery of a listed species. The status reviews for ESA-listed salmonids within the action area lament the lack of data available for making satisfactory management decisions (Busby et al. 1996, NOAA Fisheries 1997a, Myers et al. 1998). The lack of reliable and widespread abundance and trend data is in itself a risk factor for listed salmonids within the action area. Access to useful scientific information is essential to implement the ESA adequately. Scientific information is necessary to reduce uncertainty in determining whether a consultation is to be conducted formally or informally, in determining whether an action jeopardizes a listed species and when developing terms and conditions, reasonable and prudent measures, and reasonable and prudent alternatives.

NOAA Fisheries is synthesizing and analyzing data generated from permitted research activities. These data will be used to reassess ongoing research activities as well as to provide information for the management and recovery of ESA-listed salmonids. In order to facilitate the restoration and recovery of ESA-listed salmonids within the action area, scientific research programs directed toward developing a more robust and complete body of information is needed. Typical research activities permitted by NOAA Fisheries in the past have looked at: presence/absence, population trends, spatial distributions, habitat use, genetics, and population dynamics (i.e., relative abundance, reproduction, growth, and mortality). Other types of research likely to be proposed would investigate: diet, behavior, migration patterns, and impacts of resource management practices on ESA-listed salmonids. Resulting information from these types of research projects is valuable when management decisions are being made which might affect salmon. Also, monitoring activities can help NOAA Fisheries determine if protective actions are assisting in the recovery of listed species within the action area. Having data available to resource managers reduces uncertainty in management decisions. Therefore, research can facilitate recovery.

VI. CUMULATIVE EFFECTS

Cumulative effects are defined in 50 CFR 402.02 as "those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation." For the purpose of this analysis, the action area that is the subject of this opinion is the Central Valley of California. Future Federal actions, including the ongoing operation of dams, hatcheries, fisheries, water withdrawals, and land management activities will be reviewed through separate ESA section 7 consultation processes and not considered here. Non-Federal actions which may affect listed species within the action area considered in this biological opinion include: urbanization, changes in agricultural practices or demand for agricultural products, changes in State hatchery practices, State angling regulations, and voluntary State or private sponsored habitat restoration activities.

The following is a summary of potential cumulative effects that may affect the listed salmonids in the action area. However, due to the large size of the action area and the many entities and land uses that occur within this area, a precise discussion of reasonably certain to occur actions at the programmatic scale would be speculative and infeasible. NOAA Fisheries will include an analysis of cumulative effects in the tiering documents for each permit issued.

Tribal, State, and local government actions will likely be in the form of legislation, administrative rules or policy initiatives, and may encompass changes in land and water uses or intensity of use, which could impact listed species or their habitat. Tribal and government actions are subject to political, legislative, and fiscal uncertainties that will determine participation and, therefore, the effect such actions have on listed species. These realities, added to the geographic scope of the action area which encompasses numerous government entities exercising various authorities and the many private landholdings, make any analysis of cumulative effects difficult and speculative.

Tribal governments will continue to participate in cooperative efforts involving watershed and basin planning designed to improve fish habitat. Tribal governments will need to put into practice comprehensive and beneficial natural resource programs if they are to have measurable positive effects on listed species and their habitat.

The state of California administers the allocation of water resources within its borders. State and local governments are cooperating with each other and Federal agencies to increase environmental protections, including better habitat restoration and hatchery and harvest reforms. NOAA Fisheries also cooperates with the State water resource management agencies in assessing water resource needs in the action area and in developing flow requirements that will benefit listed fish. During low-water years, however, there may not be enough flow to meet the needs of fish. Moreover, these government efforts could be reduced or even discontinued, so their cumulative effect on listed fish is unpredictable.

Local governments will be faced with similar, but more direct pressures from population growth and movement. The reaction of local governments to such pressures is difficult to assess at this time. In the past, local governments in the action area generally accommodated additional growth in ways that adversely affected listed fish habitat. Also, there is little consistency among local governments in dealing with land use and environmental issues, so any positive effects that local government actions have on listed species and their habitat are likely to be scattered throughout the action area.

A. Urbanization

California is projected to be the #1 state in the United States in projected growth of human populations in both percent change and numbers of individuals with nearly 18 million new residents, and a projected increase of more than 55 percent by 2025 (U.S. Census Bureau, www.census.gov). Placer County is the second fastest growing county in California, and is the fastest growing county within the action area. Table 3 shows recent historic human population growth within the action area. Increased human population will: place greater demands in the action area for electricity, water, and land with development potential; increase demand for waste disposal sites; affect water quality directly and indirectly; and increase the need for transportation, communication, and other infrastructure development. In addition, increasing water demands, which affects water quality and quantity, riparian function, and stream productivity, will continue to impact salmonid populations in the future throughout the action area. As anthropogenic effects are generally accepted as the major cause for the decline of salmonids within coastal California watersheds, it does not seem likely that these effects will be lessened as the human population growth rate in this area is one of the highest in California. Furthermore, the increasing demand for water will likely challenge CALFED's and Central Valley Project Improvement Act's ability to provide aquatic habitat for listed salmonid species.

The effects of private actions are the most uncertain. Private landowners may change, intensify, or diminish their current land and water uses, possibly impacting salmonids and their habitat. Individual landowners may voluntarily initiate actions to improve environmental conditions, or they may abandon or resist any improvement efforts. Their actions may be compelled by new laws, or may arise out of population growth and economic pressures. Changes in ownership patterns will have unknown impacts. NOAA Fisheries is unable to effectively predict the possible effects of private actions.

Another problem with increasing urbanization is waste water discharges. Waste water discharges can result in negative thermal effects, associated organic input into aquatic systems, changes in aquatic invertebrate communities, increased algae and phytoplankton, and elevated coliform bacteria levels. Nonpoint source discharges are known to occur as a result of failing septic systems and other sources throughout the action area. Point source discharges occur at storm water drains or other discrete locations. Sediment input into streams results from bank slope failure along logged streams where vegetation has been removed or from unpaved roads that are poorly maintained. Discharges from identified point sources of wastewater are expected to be conducted under applicable State and Federal laws.

B. Water Withdrawals and Diversions

It is anticipated that environmental impacts from water withdrawals will continue at their present levels or increase as the result of the state's expected increase in population size. These impacts will include localized dewatering of stream reaches, entrapment of younger salmonids, and depletion of flows necessary for migration, spawning, rearing, flushing of sediment from spawning gravels, gravel recruitment, and transport of large woody debris. Unprotected or poorly screened water diversions will continue to impact young salmonids with fry being drawn into water pumps or being stuck against the pump's screened intakes.

C. Agriculture

The action area has three of the top seven counties producing agricultural products in California (i.e., Merced, San Joaquin and Stanislaus counties; California Department of Food and Agriculture 2002). Agricultural activities include livestock grazing, dairy farming, and the cultivation of crops. The recent upward trend in the value of agricultural products is likely to continue as human populations increase. The impacts of this land use on aquatic species include decreased soil stability, loss of shade- and cover-producing riparian vegetation, increased sediment inputs, and elevated coliform bacteria levels. In addition, the placement of temporary dams, used to facilitate water supply for irrigation, may cause migrational barriers and habitat alteration for juvenile salmonids or create lentic habitats beneficial to nonnative predatory fish species.

D. Chemical Use

It is anticipated that chemicals such as pesticides, herbicides, fertilizers, and fire retardants will continue to be used in the action area. Impacts to salmonids may include changes to riparian vegetation and associated organic input into aquatic systems, changes in aquatic invertebrate communities, and increased algae and phytoplankton. Determining the effects of chemical applications is difficult due to the lack of specific information. In the future, NOAA Fisheries expects to consult on Federal actions involving chemical use. However until that time, these activities are part of the cumulative effects in the action area.

E. Hatcheries

State hatchery practices could reduce natural stocks of listed salmonids and their overall populations through competition, reduction in genetic diversity, and disease transmission resulting from hatchery introductions. However, the effects of hatchery practices on listed salmonids may also depend on other factors such as predation and habitat quantity and quality. Efforts are currently underway between NOAA Fisheries and the State to modify existing hatchery practices in ways to augment salmon and steelhead populations without having detrimental effects on naturally spawning populations. Through the close evaluation of practices at all Central Valley salmon and steelhead hatcheries, the State is expected to determine the effects on wild populations and take steps to change hatchery practices if needed. In the future, NOAA Fisheries expects to consult on Federal hatchery activities. However until that time, these activities are part of the cumulative effects in the action area.

F. Angling

State angling regulations are generally moving towards greater restrictions to protect listed fish species. Through seasonal and area closures, greater numbers of adult listed fish are expected to complete their migration to upstream spawning areas. Mass marking of juvenile anadromous fish produced at Central Valley hatcheries could allow for the implementation of selective ocean and in-river harvest. A selective fishery that targets only externally marked hatchery production and that releases unmarked naturally spawned fish may significantly reduce harvest rates on listed salmonids. In general, these changes in State angling regulations are expected to increase populations of listed salmonids.

G. Stream Restoration

Restoration activities may cause temporary increases in turbidity, alter channel dynamics and stability, and temporarily stress salmonids. Properly constructed stream restoration projects may increase available habitat, habitat complexity, stabilize channels and streambanks, increase spawning gravels, decrease sedimentation, and increase shade and cover for salmonids. There are several stream enhancement projects that are funded by State and/or private entities (e.g., CALFED, The Nature Conservancy, etc.). The effects of such actions are expected to be temporary and localized. The overall effects of these activities are considered beneficial to the long-term viability of salmonid populations.

H. Summary

Non-Federal activities within the action area are expected to increase with a projected 52 percent increase in human population over the next 25 years in the Central Valley of California. Thus, NOAA Fisheries assumes that future private and State actions will continue within the action area, but at increasingly higher levels as population density climbs. The cumulative effects in the action area are difficult to analyze considering the large geographic scope of this opinion, the different resource authorities in the action area, the uncertainties associated with government and private actions, and the changing economies of the region. Whether these effects will increase or decrease is a matter of speculation; however, based on the trends identified in this section, the adverse cumulative effects are likely to increase. Although State, tribal and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NOAA Fisheries can consider them "reasonably certain to occur" in its analysis of cumulative effects.

VII. INTEGRATION AND SYNTHESIS OF EFFECTS

Populations of Chinook salmon and steelhead in California have declined drastically over the last century and some subpopulations of salmonids have been lost. There are three ESUs of salmonids in the Central Valley listed as endangered or threatened under the ESA. The current status of listed salmonids in the Central Valley of California, based upon their risk of extinction, has not significantly improved since the species were listed (NOAA Fisheries 2003). For example, although the number of Sacramento River winter-run Chinook salmon has increased in the last six years, the ESU remains at risk of extinction (NOAA Fisheries 2003). This severe decline in population over many years, as discussed in Section III, as well as all the expected cumulative effects, demonstrates the need for actions which will assist in the recovery of all of the listed salmonids in the action area, and that if measures are not taken to reverse these trends, the continued existence of these species could be at risk.

A major cause of the decline of anadromous salmonids in California is the loss or severe decrease in quality and function of essential habitat. Most of this habitat loss and degradation has resulted from anthropogenic watershed disturbances caused by agriculture, water diversion, urban development, erosion and flood control, dams, forestry, and gravel mining. Most of this habitat degradation is associated with the loss of essential habitat components necessary for the survival of anadromous salmonids.

The present body of scientific information relative to the abundance, distribution, and genetic composition of anadromous salmonid populations in the Central Valley is incomplete. However, the recent formation of the Central Valley Technical Recovery Team will facilitate the synthesis of these data on listed salmonids in the Central Valley. This paucity of data limits the ability of managers to evaluate proposed recovery actions. In order to facilitate the restoration and recovery of ESA-listed salmonids in the Central Valley, a mechanism directed toward developing a more robust and complete body of information is needed.

NOAA Fisheries SWR proposes to issue permits that would implement various monitoring programs for listed salmonids in the Central Valley. This information can improve the knowledge of Chinook salmon and steelhead life history, their biological requirements, genetic structure, migration timing, population estimates or trends, and their distribution. Also, the information can help NOAA Fisheries determine if protective actions are assisting in the recovery of listed species in the action area.

To expedite the process of issuing permits, NOAA Fisheries is using a programmatic consultation. The objective of this biological opinion is to determine whether the program directing issuance of research permits will reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species. Specifically, this opinion evaluates the impacts from authorizing take through the gathering of scientific information under section 10(a)(1)(A) of the ESA for purposes of enhancing recovery of listed salmonid species in the action area.

Specific activities involving take of ESA-listed salmonids authorized by these permits may include: surveys by direct observation, capture by standard fishery gears, tagging, and other activities necessary to conduct studies aimed at the recovery of the species. The effect of this proposed action will consist of temporary behavior modification and rare instances of physical damage and/or possible mortality as a result of harassment, capture, or handling of individual fish. The potential impacts to individual ESA-listed salmonids are expected to be confined to specific sampling sites within the action area.

NOAA Fisheries will insure against jeopardy both on individual research permits and on the aggregate effects of the research program through consideration of project geography, timing, sampling frequency, and annual reassessment of project impacts to ESA-listed salmonids. Detrimental impacts of the actions will be minimized or eliminated by issuing permits based upon a prioritized research system, requiring research be conducted consistently with relevant NOAA Fisheries' guidelines, and specifying terms and conditions in each permit that will minimize the effect of taking on individuals to the maximum extent possible. Although proposed research activities may have an adverse impact on listed salmonids, NOAA Fisheries would restrict issuance of permits to only those entities performing activities that facilitate the recovery of ESA-listed salmonids. If the negative impacts are realized, they are unlikely to reduce the potential for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead to survive and recover on an ESU scale. NOAA Fisheries believes that the studies implemented after issuance of the permits will make a significant contribution to the body of scientific knowledge and assist in conservation and management decisions that may lead to the recovery of ESA-listed salmonids in the Central Valley.

VIII. CONCLUSION

After reviewing the best available science and commercial data regarding the current status of endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, and threatened Central Valley steelhead, the environmental baseline for the action area, the effects of the program directing issuance or modification to section 10(a)(1)(A) permits, and cumulative effects, it is NOAA Fisheries' biological opinion that issuance of section 10(a)(1)(A) permits, as proposed, is not likely to jeopardize the continued existence of endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, and threatened Central Valley steelhead

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. NOAA Fisheries interprets the term "harm" as an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.

The issuance of section 10(a)(1)(A) permits or permit modifications are for intentional take of listed Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead associated with scientific research and enhancement activities. Where there is overlap of listed salmonids in a given habitat, the permit authorizes take of all listed salmonids. Taking of threatened or endangered species that is incidental to and not intended as part of the proposed action is not anticipated. This opinion does not authorize any taking of a listed species under section 10(a) or immunize any actions from the prohibitions of section 9(a) of the ESA.

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

NOAA Fisheries recommends that NOAA Fisheries SWR develop and implement outreach programs promoting conservation and recovery of listed salmonids. Also, NOAA Fisheries recommends that NOAA Fisheries SWR Research and Enhancement Permit Coordinator meet regularly with the Central Valley Recovery Team to ensure that the research priorities and recommendations of the NOAA Fisheries Technical Recovery Teams are considered when issuing or modifying section 10(a)(1)(A) permits. These conservation recommendations can help offset the short-term, negative impacts of take for purposes of gathering fisheries management information on Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead

In order for NOAA Fisheries to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NOAA Fisheries requests notification of implementation of any conservation recommendations.

XI. REINITIATION OF CONSULTATION

This concludes formal consultation on the issuance of scientific research permits for activities within the California Central Valley. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, NOAA Fisheries must immediately reinitiate consultation.

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Volume 65 pages 42422-42481. July 10, 2000. National Marine Fisheries Service. Final Rule: Governing Take of 14 Threatened Salmon and Steelhead Evolutionary Significant Units.

Volume 67 pages 1116-1133. January 9, 2002. National Marine Fisheries Service. Final Rule: Governing Take of Four Threatened Evolutionarily Significant Units (ESUs) of West Coast Salmonids.

Table 1. References for additional background on listing status, critical habitat, protective regulations, and biological information for the listed species addressed in this opinion.

ESU	Listing Status	Critical Habitat	Protective Regulations	Biological Information
Sacramento River winter-run Chinook salmon	Endangered Jan 4, 1994 59 FR 440	Jun 16, 1993 58 FR 33212	Nov 5, 1990 55 FR 46515	Boles 1988; USFWS 1995; NOAA Fisheries 1997a
Central Valley spring-run Chinook salmon	Threatened Sep 16, 1999 64 FR 50394	Withdrawn Apr 30, 2002 consent decree	Jan 9, 2002 67 FR 1116	Campbell and Moyle 1990; Myers et al. 1998
Central Valley steelhead	Threatened Mar 19, 1998 63 FR 13347	Withdrawn Apr 30, 2002 consent decree	Jul 10, 2000 65 FR 42422	Barnhart 1986; Busby et al. 1996; McEwan and Jackson 1996

Table 2. Types of research data needed to address recovery issues for Central Valley salmonids. (Source: Steve Lindley, NOAA Fisheries, personal communication 2/7/03)

Sacramento River winter-run, Central Valley spring-run, fall-run and late-fall run Chinook salmon

Abundance:

Escapement by age and sex, and assessment of variance in escapement

Juvenile outmigration from spawning areas estimated by true population estimates (rather than "indices of abundance")

Survival:

Survival rate by life stage

Predation rate estimates

Methods: test assumptions of *mark-recapture models* applied to carcass surveys

Life history: archive scales and otoliths collected in carcass surveys for future analysis of environmental effects on *growth*

Habitat: *habitat quality* to help explain variation in fish parameters (e.g., abundance and survival)

Central Valley spring-run Chinook salmon

Life history: quantitative surveys of summer juveniles in Butte, Deer, and Mill Creeks to determine prevalence of the *yearling migrant life history*

Central Valley fall-run Chinook salmon

Distribution:

Constant fractional *marking* with systematic sampling of spawners for marks

In-river catches to estimate *straying rate* of hatchery fish into natural spawning areas

Life history: measure *reproductive performance* of hatchery fish spawning in the wild

Central Valley steelhead

Abundance: counting weirs or redd surveys wherever feasible

Distribution: identify areas where *natural spawning* is occurring and where juveniles *over-summer*

Life history: determine relationships between resident and anadromous groups (e.g., otolith microchemistry studies of juvenile *O. mykiss* in below-barrier streams)

Genetics: determine relationships between anadromous and above-barrier trout populations

Table 3. Human population in 2000 and percent growth of human population from 1990 to 2000 of the California counties within or partially in the action area of this opinion. [Source: U.S. Census Bureau.]

County	2000 Population	Percent Growth from 1990-2000
Alpine	1,208	8.5 %
Amador	35,100	16.8 %
Butte	203,171	11.6 %
Calaveras	40,554	26.7 %
Colusa	18,804	15.5 %
Contra Costa	948,816	18.1 %
El Dorado	156,299	24.1 %
Fresno	799,407	19.8 %
Glenn	26,453	6.7 %
Lake	58,309	15.2 %
Madera	123,109	39.8 %
Mariposa	17,130	19.8 %
Mendocino	86,265	7.4 %
Merced	210,554	18.0 %
Napa	124,279	12.2 %
Nevada	92,033	17.2 %
Placer	248,399	43.8 %
Plumas	20,824	5.5 %
Sacramento	1,223,499	14.7 %
San Benito	53,234	45.1 %
San Joaquin	563,598	17.3 %
Shasta	163,256	11.0 %
Sierra	3,555	7.1 %
Solano	394,542	16.2 %
Stanislaus	446,997	20.6 %
Sutter	78,930	22.5 %
Tehama	15,039	12.9 %
Trinity	13,022	- 0.3 %
Tuolumne	54,501	12.5 %
Yolo	168,660	19.4 %
Yuba	60,219	3.4 %
Total Population and Ave.	**6,449,766**	**18.1 %**

Figure 1

Figure 2

Figure 3. Escapement estimates for Sacramento River winter-run Chinook salmon from Red Bluff Diversion Dam ladder counts from 1967-2002. (Source: DFG 2002)

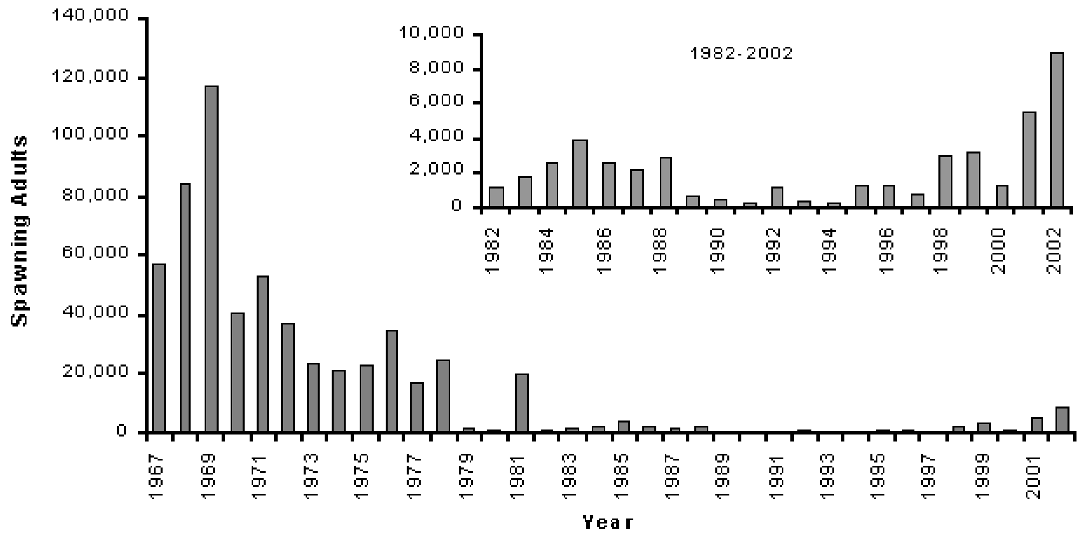
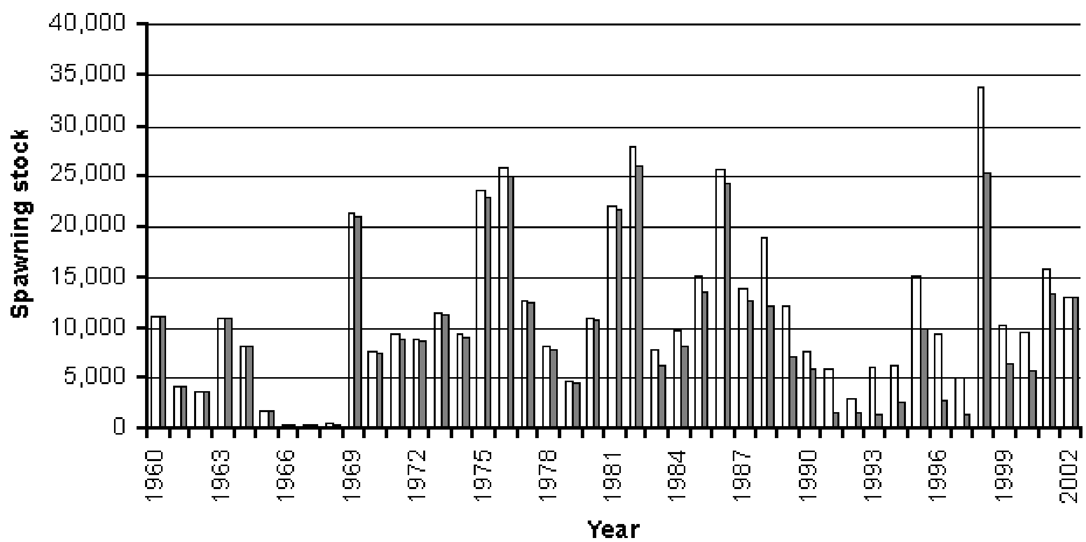


Figure 4. Spawning stock estimates (adults and grilse) for Central Valley spring-run Chinook salmon from 1960-2002. Estimates include fall-run/spring-run hybrids from the Feather River Hatchery (outline) and total unhybridized spring-run Chinook salmon (shaded). (Source: DFG unpublished data)



APPENDIX A - NOAA Fisheries Electrofishing Guidelines

All permit holders performing electrofishing in waters containing ESA-listed salmonids will follow these guidelines.

National Marine Fisheries Service
Guidelines for Electrofishing Waters Containing
Salmonids Listed Under the Endangered Species Act

June 2000

Purpose and Scope

The purpose of this document is to provide guidelines for the safe use of backpack electrofishing in waters containing salmonids listed by the National Marine Fisheries Service (NMFS) under the Endangered Species Act (ESA). It is expected that these guidelines will help improve electrofishing technique in ways which will reduce fish injury and increase electrofishing efficiency. These guidelines and sampling protocol were developed from NMFS research experience and input from specialists in the electrofishing industry and fishery researchers. This document outlines electrofishing procedures and guidelines that NMFS has determined to be necessary and advisable when working in freshwater systems where threatened or endangered salmon and steelhead may be found. As such, the guidelines provide a basis for reviewing proposed electrofishing activities submitted to NMFS in the context of ESA Section 10 permit applications as well as scientific research activities proposed for coverage under an ESA Section 4(d) rule.

These guidelines specifically address the use of backpack electrofishers for sampling juvenile or adult salmon and steelhead that are not in spawning condition. Electrofishing in the vicinity of adult salmonids in spawning condition and electrofishing near redds are not discussed as there is no justifiable basis for permitting these activities except in very limited situations (e.g., collecting brood stock, fish rescue, etc.). The guidelines also address sampling and fish handling protocols typically employed in electrofishing studies. While the guidelines contain many specifics, they are not intended to serve as an electrofishing manual and do not eliminate the need for good judgement in the field.

Finally, it is important to note that researchers wishing to use electrofishing in waters containing listed salmon and steelhead are not necessarily precluded from using techniques or equipment not addressed in these guidelines (e.g., boat electrofishers). However, prior to authorizing the take of listed salmonids under the ESA, NMFS will require substantial proof that such techniques/equipment are clearly necessary for a particular study and that adequate safeguards will be in place to protect threatened or endangered salmonids. Additional information regarding these guidelines or other research issues dealing with salmon and steelhead listed under the ESA can be obtained from NMFS' Protected Resources Divisions in:

Washington, Oregon, and Idaho	*California*
Leslie Schaeffer	Daniel Logan
National Marine Fisheries Service	National Marine Fisheries Service
525 NE Oregon Street, Suite 500	777 Sonoma Ave., Room 325
Portland, Oregon 97232-2737	Santa Rosa, California 95404-6515
(503) 230-5433 – telephone	(707) 575-6053 – telephone
Internet Address: leslie.schaeffer@noaa.gov	Internet Address: dan.logan@noaa.gov

Appropriateness of Electrofishing

Backpack electrofishing for salmonids has been a principal sampling technique for decades, however, recent ESA listings underscore the need to regulate the technique and assess its risks and benefits to listed species (Nielsen 1998). With over 25 Evolutionarily Significant Units (ESUs) of threatened or endangered salmonids now identified along the U.S. West Coast, researchers can expect to encounter one or more listed species in nearly every river basin in California, Oregon, Washington, and Idaho. There are few if any non-invasive ways to collect distribution, abundance, or morphophysiological data on salmonids in freshwater. This is reflected in the requirement that all activities that involve intentional take of juvenile salmonids for research or enhancement of an ESA listed species require an ESA Section 10 permit from NMFS. While NMFS has not precluded the use of electrofishing in all cases, researchers must present rigorous study designs and methods for handling fish prior to NMFS authorizing electrofishing to take listed salmonids under the ESA.

NMFS believes there is ample evidence that electrofishing can cause serious harm to fish and the general agency position is to encourage researchers to seek out other less invasive ways to sample listed species. Direct observation by snorkeling is one of the least invasive ways to collect information concerning abundance and distribution, although there can be both practical (e.g., poor viability) and statistical (e.g., large numbers of fish, low observation probability) constraints to direct observation. Preliminary efforts should be directed at study designs that use less invasive methods. If such methods cannot provide the quality of data required or when the benefit exceeds potential mortality risk, then electrofishing can be considered. Electrofishing used on a limited basis to calibrate direct observations (e.g., Hankin and Reeves 1988) is commonly used and methods are currently under development that increase the use of direct observation counts (e.g., bounded counts, “multiple snorkel passes”) which, in many cases, will further reduce the need for electrofishing.

Electrofishing Guidelines

Training

Field supervisors and crew members must have appropriate training and experience with electrofishing techniques. Training for field supervisors can be acquired from programs such as those offered from the U.S. Fish and Wildlife Service - National Conservation Training Center (Principles and Techniques of Electrofishing course) where participants are presented information concerning such topics as electric circuit and field theory, safety training, and fish injury awareness and minimization. A crew leader having at least 100 hours of electrofishing experience in the field using similar equipment must train the crew. The crew leader's experience must be documented and available for confirmation; such documentation may be in the form of a logbook. The training must occur before an inexperienced crew begins any electrofishing and should be conducted in waters that do not contain ESA-listed fish. Field crew training must include the following elements:

1. A review of these guidelines and the equipment manufacturer's recommendations, including basic gear maintenance.

2. Definitions of basic terminology (e.g., galvanotaxis, narcosis, and tetany) and an explanation of how electrofishing attracts fish.

3. A demonstration of the proper use of electrofishing equipment (including an explanation of how gear can injure fish and how to recognize signs of injury) and of the role each crew member performs.

4. A demonstration of proper fish handling, anesthetization, and resuscitation techniques.

5. A field session where new individuals actually perform each role on the electrofishing crew.

Research Coordination

Research activities should be coordinated with fishery personnel from other agencies/parties to avoid duplication of effort, oversampling small populations, and unnecessary stress on fish. Researchers should actively seek out ways to share data on threatened and endangered species so that fish samples yield as much information as possible to the research community. NMFS believes that the State fishery agencies should play a major role in coordinating salmonid research and encourages researchers to discuss their study plans with these agencies prior to approaching NMFS for an ESA permit.

Initial Site Surveys and Equipment Settings

1. In order to avoid contact with spawning adults or active redds, researchers must conduct a careful visual survey of the area to be sampled before beginning electrofishing.

2. Prior to the start of sampling at a new location, water temperature and conductivity measurements should be taken to evaluate electroshocker settings and adjustments. No electrofishing should occur when water temperatures are above 18˚C or are expected to rise above this temperature prior to concluding the electrofishing survey. In addition, studies by NMFS scientists indicate that no electrofishing should occur in California coastal basins when conductivity is above 350 µS/cm.

3. Whenever possible, a block net should be placed below the area being sampled to capture stunned fish that may drift downstream.

4. Equipment must be in good working condition and operators should go through the manufacturer's preseason checks, adhere to all provisions, and record major maintenance work in a logbook.

5. Each electrofishing session must start with all settings (voltage, pulse width, and pulse rate) set to the minimums needed to capture fish. These settings should be gradually increased only to the point where fish are immobilized and captured, and generally not allowed to exceed conductivity-based maxima (Table 1). Only direct current (DC) or pulsed direct current (PDC) should be used.

Table 1. Guidelines for initial and maximum settings for backpack electrofishing.

Parameter	*Initial Settings*	*Maximum Settings*		*Notes*
Voltage	100 V	Conductivity (µS/cm)	Max. Voltage	In California coastal basins, settings should never exceed 400 volts. Also, no electrofishing should occur in these basins if conductivity is greater than 350 µS/cm.
		< 100	1100 V	
		100 - 300	800 V	
		> 300	400 V	
Pulse width	500 µs	5 ms		
Pulse rate	30 Hz	70 Hz		In general, exceeding 40 Hz will injure more fish

Electrofishing Technique

1. Sampling should begin using straight DC. Remember that the power needs to remain on until the fish is netted when using straight DC. If fish capture is unsuccessful with initial low voltage, gradually increase voltage settings with straight DC.

2. If fish capture is not successful with the use of straight DC, then set the electrofisher to lower voltages with PDC. If fish capture is unsuccessful with low voltages, increase pulse width, voltage, and pulse frequency (duration, amplitude, and frequency).

3. Electrofishing should be performed in a manner that minimizes harm to the fish. Stream segments should be sampled systematically, moving the anode continuously in a herringbone pattern (where feasible) through the water. Care should be taken when fishing in areas with high fish concentrations, structure (e.g., wood, undercut banks) and in shallow waters where most backpack electrofishing for juvenile salmonids occurs. Voltage gradients may be high when electrodes are in shallow water where boundary layers (water surface and substrate) tend to intensify the electrical field.

4. Do not electrofish in one location for an extended period (e.g., undercut banks) and regularly check block nets for immobilized fish.

5. Fish should not make contact with the anode. Remember that the zone of potential injury for fish is 0.5 m from the anode.

6. Electrofishing crews should be generally observant of the condition of the fish and change or terminate sampling when experiencing problems with fish recovery time, banding, injury, mortality, or other indications of fish stress.

7. Netters should not allow the fish to remain in the electrical field any longer than necessary by removing stunned fish from the water immediately after netting.

Sample Processing and Recordkeeping

1. Fish should be processed as soon as possible after capture to minimize stress. This may require a larger crew size.

2. All sampling procedures must have a protocol for protecting held fish. Samplers must be aware of the conditions in the containers holding fish; air pumps, water transfers, etc., should be used as necessary to maintain safe conditions. Also, large fish should be kept separate from smaller prey-sized fish to avoid predation during containment.

3. Use of an approved anesthetic can reduce fish stress and is recommended, particularly if additional handling of fish is required (e.g., length and weight measurements, scale samples, fin clips, tagging).

4. Fish should be handled properly (e.g., wetting measuring boards, not overcrowding fish in buckets, etc.).

5. Fish should be observed for general condition and injuries (e.g., increased recovery time, dark bands, apparent spinal injuries). Each fish should be completely revived before releasing at the location of capture. A plan for achieving efficient return to appropriate habitat should be developed before each sampling session. Also, every attempt should be made to process and release ESA-listed specimens first.

6. Pertinent water quality (e.g., conductivity and temperature) and sampling notes (e.g., shocker settings, fish condition/injuries/mortalities) should be recorded in a logbook to improve technique and help train new operators. It is important to note that records of injuries or mortalities pertain to the entire electrofishing survey, including the fish sample work-up.

Citations and Other References

Dalbey, S. R., T. E. McMahon, and W. Fredenberg. 1996. Effect of electrofishing pulse shape and electrofishing-induced spinal injury on long-term growth and survival of wild rainbow trout. North American Journal of Fisheries Management 16:560-569.

Hankin, D. G., and G. H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Fisheries and Aquatic Sciences 45:834-844.

Hollender, B. A., and R. F. Carline. 1994. Injury to wild brook trout by backpack electrofishing. North American Journal of Fisheries Management 14:643-649.

Nielsen, J. L. 1998. Electrofishing California's endangered fish populations. Fisheries 23:6-12.

Nielsen, L.A., and D.L. Johnson, editors. 1983. Fisheries techniques. American Fisheries Society, Bethesda, Maryland.

Reynolds, J. B., and A. L. Kolz. 1988. Electrofishing injury to large rainbow trout. North American Journal of Fisheries Management 8:516-518.

Sharber, N. G., and S. W. Carothers. 1988. Influence of electrofishing pulse shape on spinal injuries in adult rainbow trout. North American Journal of Fisheries Management 8:117-122.

Sharber, N. G., S. W. Carothers, J.P. Sharber, J. D. de Bos, Jr., and D. A. House. 1994. Reducing electrofishing-induced injury of rainbow trout. North American Journal of Fisheries Management 14:340-346.

Schreck, C.B., and P.B. Moyle, editors. 1990. Methods for fish biology. American Fisheries Society, Bethesda, Maryland.

APPENDIX B - General Permit Conditions

Following are permit conditions that NOAA Fisheries SWR will include in all ESA section 10(a)(1)(A) permits. Additional project-specific permit conditions will be developed and added to each permit.

A. Permit Reporting and Reauthorization Requirements

The NOAA Fisheries will require all Permit Holders to provide an annual report of the activities conducted under their permits. All Permit Holders must submit periodic reports to NOAA Fisheries describing in detail all research activities undertaken and proposed. All reports and notifications must be sent to: Research Permits Coordinator, Protected Resources Division, 777 Sonoma Avenue, Room 325, Santa Rosa, California 95403, (707) 575-6053, (707) 578-3435 (FAX). For the duration of any permit authorized by this opinion, work in each succeeding year is contingent on submission and approval of a report on each preceding year's research activities. Annual reports are due by October 1 each year. The information provided shall include, but not be limited to:

1. Summary presentations and brief discussions of significant research results;

2. Maps and/or descriptions of location sampled;

3. Results of all sampling efforts including estimates of population size, if possible;

4. Quantification of take, including numbers of individuals intentionally and incidentally killed, including dates, locations, and circumstances of lethal take, and an estimate of the numbers of individuals otherwise harmed or harassed (e.g., handled in a fish trap or displaced during snorkeling surveys);

5. Other pertinent observations made during sampling efforts regarding the status of ecology of the species, including size of individuals and presumed life-history form; and

6. Planned future activities if authorized under this permit.

    a. A detailed description of activities conducted under this permit, including the total number of fish taken at each location, an estimate of the number of ESA-listed fish taken at each location, the manner of take, and the dates/locations of take;

    b. Measures taken to minimize disturbances to ESA-listed fish and the effectiveness of these measures, the condition of ESA-listed fish taken and used for research, a description of the effects of research activities on the subject species, the disposition of ESA-listed fish in the event of mortality, and a brief narrative of the circumstances surrounding ESA-listed fish injuries or mortalities;

c. Any problems which may have arisen during the research activities, and a statement as to whether or not the activities had any unforeseen effects;

d. A description of how all take estimates were derived;

e. Any preliminary analyses of the data;

f. Steps that have been and will be taken to coordinate the research with that of other researchers; and

g. If an electroshocker was used for fish collection, a copy of the logbook must be included with the report.

7. The Permit Holder must submit a final report within ninety (90) days of the expiration of this permit summarizing the results of the research and the success of the research relative to its goals.

B. Operational Reports and Notification Requirements

1. The Permit Holder must provide plans for future undefined projects and/or changes in sampling locations or research protocols and obtain approval from NOAA Fisheries prior to implementation.

2. Prior to each research sampling season, the Permit Holder must identify the personnel designated to act under the authority of this permit and confirm their experience through résumés or other evidence of their qualifications.

3. The Permit Holder must provide notice of intended activities at least two weeks in advance of each research sampling season to enable a NOAA Fisheries official(s), or any other person(s) duly designated, to accompany researchers. The required notification shall include a detailed outline of coordination measures that will be undertaken with other researchers to insure that no unnecessary duplication and/or adverse cumulative impacts occur as a result of the research activities.

4. The Permit Holder must report whenever the authorized level of take is exceeded, or if circumstances indicate that such an event is imminent. Notification should be made as

soon as possible, but no later than two days after the authorized level of take is exceeded. The Permit Holder must then submit a detailed written report. Pending review of these circumstances, NOAA Fisheries may suspend research activities or amend this permit to allow research activities to continue.

5. The Permit Holder must report the take of any ESA-listed species not included in this permit, when it is killed, injured, or collected during the course of research activities. Notification should be made as soon as possible, but no later than two days after the unauthorized take. The Permit Holder must then submit a detailed written report. Pending review of these circumstances, NOAA Fisheries may suspend research activities or amend this permit to allow research activities to continue.

C. General Conditions

7. The Permit Holder must insure that the ESA-listed species are taken only by the means, in the areas, and for the purposes set forth in the permit application, as limited by the terms and conditions in this permit.

8. The Permit Holder must insure that all ESA-listed species are handled carefully. Should NOAA Fisheries determine that a procedure provided for under this permit is no longer acceptable, the Permit Holder must immediately cease such activity until NOAA Fisheries determines an acceptable substitute procedure.

9. The Permit Holder, in effecting the take authorized by this Permit, is considered to have accepted the terms and conditions of this permit and must be prepared to comply with the provisions of this permit, the applicable regulations, and the ESA.

10. The Permit Holder is responsible for the actions of any individual operating under the authority of this permit. Such actions include capturing, handling, releasing, transporting, maintaining, and caring for any ESA-listed species authorized to be taken by this permit.

11. The Permit Holder, personnel, or designated agent acting on the Permit Holder's behalf must possess a copy of this permit when conducting the activities for which a take of ESA-listed species or other exception to ESA prohibitions is authorized herein.

12. The Permit Holder may not transfer or assign this permit to any other person(s), as person is defined in section 3(12) of the ESA. This permit ceases to be in force or effective if transferred or assigned to any other person without prior authorization from NOAA Fisheries.

13. The Permit Holder must obtain any other Federal, State, and local permits/authorizations necessary for the conduct of the activities provided for in this permit. In addition, before taking ESA-listed species in the territorial waters of a foreign country, the Permit Holder must secure consent from, and comply with the appropriate laws of, that country.

14. Any personnel of the Permit Holder requiring Federal or State licenses to practice their profession must be duly licensed under the appropriate law.

15. The Permit Holder must coordinate with other co-managers and/or researchers to insure that no unnecessary duplication and/or adverse cumulative effects occur as a result of the Permit Holder’s activities.

16. The Permit Holder must allow any NOAA Fisheries employee(s) or any other person(s) designated by NOAA Fisheries, to accompany field personnel during the activities provided for in this permit. The Permit Holder must allow such person(s) to inspect the Permit Holder's records and facilities if such records and facilities pertain to ESA-listed species covered by this permit or NOAA Fisheries's responsibilities under the ESA.

17. Under the terms of the regulations, a violation of any of the terms and conditions of this permit will subject the Permit Holder, and/or any individual who is operating under the authority of this permit, to penalties as provided for in the ESA.

18. The Permit Holder is responsible for biological samples collected from ESA-listed species as long as they are useful for research purposes. The terms and conditions concerning any samples collected under this authorization remain in effect as long as the Permit Holder maintains authority and responsibility of the material taken. The Permit Holder may not transfer biological samples to anyone not listed in the application without obtaining prior written approval from NOAA Fisheries. Any such transfer will be subject to such conditions as NOAA Fisheries deems appropriate.

19. The Office of Protected Resources, NOAA Fisheries, may amend the provisions of this permit after reasonable notice to the Permit Holder.

20. 50 CFR Section 222.23(d)(8) allows NOAA Fisheries to charge a reasonable fee to cover the costs of issuing permits under the ESA. The fee for this permit has been waived.

21. NOAA Fisheries may revoke this permit if the activities provided for by it are not carried out, if the activities are not carried out in accordance with the conditions of the permit and the purposes and requirements of the ESA, or if NOAA Fisheries otherwise determines that the findings made under section 10(d) of the ESA no longer hold.

22. Any falsification of annual reports or records pertaining to this permit is a violation of this permit.

23. The Permit Holder, in signing this permit, has accepted and will comply with the provisions of this permit, applicable regulations (50 CFR 222), and the ESA.

D. Penalties and Permit Sanctions

1. Any person who violates any provision of this permit is subject to civil and criminal penalties, permit sanctions, and forfeiture as authorized under the ESA and 15 CFR part 904 [Civil Procedures].

2. All permits are subject to suspension, revocation, modification, and denial in accordance with the provisions of subpart D [Permit Sanctions and Denials] of 15 CFR part 904.